
17. Care of the Hospitalized Patient with Diabetes

Persons with diabetes have a 2- to 4-fold higher hospitalization rate than do those without diabetes. Diabetes predisposes to a number of conditions that may lead to hospitalization, including coronary artery disease, cerebrovascular disease, peripheral vascular disease, nephropathy, and infection. Poorly controlled diabetes has been associated with increased infectious complications, delayed wound healing, increased medical costs, increased length of stay, and increased mortality.

The general goals for patients with diabetes in the acute care setting are:

- Avoiding hypoglycemia or hyperglycemia
- Avoiding metabolic abnormalities, such as volume depletion or electrolyte abnormalities
- Meeting nutritional needs
- Assessing educational needs

General Principles of Care

The initial history of the patient with diabetes who is admitted to the hospital should include the following information:

- Preadmission medications for diabetes
- Home glucose monitoring results
- Outpatient diet
- Hemoglobin A1C values (if available)
- History or presence of complications from diabetes

Medical Nutrition Therapy

Nutrition during hospitalization should be individualized based on body weight, comorbidities, and expected caloric expenditure. The typical

daily dietary provision during catabolic illness is 25 to 35 kcal/kg body weight. Overfeeding should be avoided because it may contribute to hyperglycemia.

Monitoring the total amount of consumed carbohydrates remains a key strategy for achieving glycemic control. Usually, patients who are eating should be provided with a meal plan that includes a consistent amount of carbohydrates and has a low glycemic index. Such plans typically provide 1500–2000 kcal/day with about 50% of calories from carbohydrates, 20% from protein, and 30% from fat. Because nutritional requirements can vary greatly, consultation with a dietitian should be considered for any hospitalized patient with diabetes, particularly those who frequently require individual adjustments (e.g., adolescents, metabolically stressed patients, patients requiring liquid diets or tube feedings, pregnant women, and geriatric patients).

Glycemic Goals

The influence of hospitalization on glucose levels is difficult to predict because many factors are involved (**Table 17-1**). The tendency in most patients is toward hyperglycemia or frequent fluctuations. Inpatient consultation with an endocrinologist and other diabetes specialists should be considered for any patient with diabetes, particularly those with a new diagnosis of diabetes, with poorly controlled diabetes as an outpatient, with a history of not rapidly meeting glycemic goals, or with discovered educational deficiencies. Delays in consultation frequently are associated with an increased length of stay.

Critically Ill Patients

Multiple controlled studies support the use of insulin and tight glycemic control in critically ill patients. Van den Berghe and colleagues have shown a 42% risk reduction in intensive care

Table 17-1. Common Factors Affecting Glycemia during Hospitalization

Increased counter-regulatory hormones
Unpredictable oral/enteral/parenteral nutrition
• Illness/nausea
• NPO for tests
• Changing meal times
• Cycled tube feedings
• Parenteral nutrition, intravenous glucose
Inactivity
Timing of insulin injections
Medications that affect glycemia (e.g., corticosteroids, vasopressors)

NPO = nothing by mouth.

unit mortality with intensive glycemic control. Similarly, the Diabetes Mellitus, Insulin Glucose Infusion in Acute Myocardial Infarction (DIGAMI) study showed that in patients with diabetes and acute myocardial infarction, insulin infusion followed by intensive subcutaneous administration of insulin improved long-term survival. The greatest effect was found in those not previously treated with insulin. The blood glucose goal recommended by the American College of Endocrinology (ACE) and the American Diabetes Association (ADA) for patients in intensive care is 80 to 110 mg/dL. A number of safe and effective insulin infusion protocols designed to achieve glycemic control in critically ill patients are now available, and many hospitals use a standardized protocol.

Non-Critically Ill Patients

Too few controlled trials have evaluated the benefit of degrees of glycemic control in hospitalized patients who are not critically ill or who have not had myocardial infarction. On the basis of available data, however, ACE and ADA recommend the following blood glucose targets for these patients:

- Pregnant patients: 80 to 100 mg/dL preprandial, <120 mg/dL 1 hour postprandial, <100 mg/dL during labor and delivery
- Other hospitalized patients: <110 mg/dL preprandial, <180 mg/dL at all other times

Regimen Adjustment in Non-Critically Ill Patients with Type 2 Diabetes

Patients with type 2 diabetes who have been treated with lifestyle modification alone and have a limited, noncritical acute illness typically do not need antihyperglycemic therapy when hospitalized. Nevertheless, blood glucose monitoring is warranted in these patients to avoid unrecognized hyperglycemia.

For patients who are taking oral diabetes drugs, the question often arises as to how to adjust their diabetes regimen during hospitalization. In patients who have had acute myocardial infarction, insulin infusion has been shown to improve outcomes, whereas sulfonylureas may increase mortality. In other settings, oral agents have not been systematically studied for inpatient use. Nevertheless, some general principles apply:

- Continuing many outpatient medications may be reasonable initially for patients without cardiac complication who were previously well controlled outside of the hospital and who are expected to eat after being hospitalized. Remember that the usual contraindications apply.
- Based on the patient's history, a dosage reduction of 25% to 50% should be considered for secretagogues because of the potentially more rigid hospital diet.
- Metformin should be immediately discontinued if any of the following is present: risk of hemodynamic instability, heart failure, dehydration, decreased renal perfusion, or impaired renal function; altered hepatic function; perioperative status; or planned radiocontrast studies.
- Thiazolidinediones (TZDs) may be continued unless New York Heart Association Class III or IV congestive heart failure occurs, concern for new or worsening edema arises, or abnormal results on liver function tests are found. Some physicians believe that TZDs simplify

hospital medications because the agents remain effective even after discontinuation.

- Alpha-glucosidase inhibitors may be continued as long as the patient is eating regularly. However, these agents should not be continued if the patient is admitted with a gastrointestinal illness or develops gastrointestinal symptoms.
- Many of the newer injectables, such as exenatide and pramlintide, affect gastrointestinal motility and are not available on most inpatient formularies. Therefore, during hospitalization, insulin therapy is often preferred.

Oral hypoglycemic agents should be discontinued and insulin used instead for patients who are not eating. The same approach is indicated if oral intake is in doubt or unpredictable. In this setting, most physicians discontinue metformin because of increased concerns about hemodynamic instability and possible radiocontrast studies. TZDs may be continued except in the presence of liver function abnormalities, concern for new edema, or heart failure. Alpha-glucosidase inhibitors should be discontinued because they are only effective when taken with meals. Reassure patients that changes in therapy, particularly the initiation of insulin, will most likely be temporary.

Insulin and the Hospitalized Patient

Insulin requirements may increase with stress or illness or decrease with prolonged starvation, frequently returning to normal with resolution of the acute illness. Patients who take insulin as an outpatient should generally continue with insulin but may require modifications to their regimen.

When determining insulin requirements during hospitalization, recognize whether a patient can produce significant endogenous insulin. Several clinical features can help identify patients who may have severe insulin deficiency (**Table 17-2**). Patients determined to be significantly insulin deficient require basal insulin replacement at

Table 17-2. Characteristics of Patients with Potentially Severe Insulin Deficiency

Known type 1 diabetes History of diabetic ketoacidosis History of pancreatectomy or severe pancreatic dysfunction Extended duration of diabetes (usually disease >10 years with insulin use >5 years) History of metabolic instability with wide fluctuations in blood sugars

all times to avoid iatrogenic diabetic ketoacidosis. This is the case even if they are normoglycemic and not eating. In these patients, intravenous glucose at 5 to 10 g/hour is often given to limit the metabolic effects of starvation. Clear or full-liquid diets should not be sugar-free. Instead, patients should consume about 200 g of carbohydrates per day in divided amounts.

Basal insulin can be provided via any one of several strategies, including continuous subcutaneous insulin infusion or subcutaneous injections of intermediate-acting insulin (including premixed insulin) or long-acting insulin. Some of these methods may result in insulin peaks exceeding the basal requirements of the patient and could result in hypoglycemia if not timed with nutritional intake. This is especially important to remember in the hospital setting, where the patient may not have control of the timing of insulin or food delivery.

Before any insulin is prescribed, the properties of individual insulins should be reviewed (see Chapter 8, Insulin and New Injectables). Some of the most common errors during hospitalization are to give an insulin with both prandial and basal characteristics and then not to match food to the prandial peak (which leads to hypoglycemia) or only to treat with prandial insulin without basal insulin (which leads to hyperglycemia). Patients treated with a peaking intermediate insulin such as neutral protamine Hagedorn (NPH) may take a bedtime snack to diminish nocturnal hypoglycemia. Such snack choices should include complex carbohydrates and protein. Insulin dosing adjustments for patients who are designated NPO (nothing by mouth) are described in the following section (Periprocedure Management of Patients with Diabetes).

In patients eating meals with a consistent amount of carbohydrates, a fixed dosage of prandial insulin may be calculated, with a correction for pre-meal blood glucose level (see Chapter 8, *Insulins and New Injectables*). For patients capable of insulin self-management during hospitalization, carbohydrate counting may allow more flexibility in the meal plan.

The rapid-acting insulin analogues provide more physiologic prandial insulin kinetics than regular insulin and may even be administered immediately after eating if the amount of food the patient will eat is unclear. However, because of their very rapid peak of action, these insulins increase the risk of hypoglycemia if they are not appropriately timed with food. They should not be administered unless the planned meal is physically present in the room. On the other hand, regular insulin is more likely to lead to hypoglycemia in the setting of “stacking” of repeated doses because regular insulin has a longer duration of action. Appropriate adjustment of basal insulin based on fasting blood sugars and planned procedures will greatly decrease variability throughout the day.

Intravenous insulin is the only method of insulin delivery specifically developed for hospital use. Intravenous delivery of insulin allows for more rapid titration and does not rely on subcutaneous absorption. For these reasons, it is preferred in the perioperative period and in patients with cardiogenic shock or other critical illnesses.

Periprocedure Management of Patients with Diabetes

The preoperative evaluation of any patient with diabetes should include a cardiopulmonary risk assessment. Several cardiac risk stratification indices, such as the Eagle index for vascular

surgery and the revised cardiac index, can help with this assessment.

If a patient with diabetes will be NPO for a procedure, scheduling the procedure early in the morning to facilitate medication adjustments is preferred. Blood glucose levels should be checked every 1 to 2 hours before, during, and immediately after procedures. The use of local or regional anesthesia is also preferred because it is less likely than general anesthesia to perturb glucose levels.

In patients with severe insulin deficiency (e.g., patients with type 1 diabetes), extra care must be taken to avoid iatrogenic ketosis. If subcutaneous insulin is to be continued, give one half to two thirds of the patient’s usual dosage of intermediate-acting (e.g., NPH) insulin. If the patient uses a peakless analogue, such as insulin glargine, either a full dose or a dosage reduction of approximately 20% may be reasonable, depending on dietary history and prior glycemic control. Small dosages of regular or rapid-acting insulin may be given as a correction dose if blood glucose is above target. For long and complex procedures, intravenous insulin and dextrose infusions adjusted to maintain target blood glucose levels are preferred.

For patients with type 2 diabetes, blood glucose levels may improve while they are still NPO. Oral medications should be adjusted as described above. Generally, all oral diabetes medications are held the morning of surgery. If subcutaneous insulin is to be continued, give one half of the intermediate-acting insulin while patients are still NPO. Otherwise, general principles such as peakless insulin dosage adjustments and rapid-acting insulin correction are the same as those described earlier. Postoperatively, the diet should be reinstated and advanced as rapidly as tolerated. Once the patient is eating and ready to return to the preoperative diabetes regimen, he or she should again be evaluated for contraindications.

- Metformin should not be restarted in patients with renal insufficiency, significant hepatic impairment, or heart failure.
- Secretagogues may need to be adjusted in a stepwise fashion based on oral intake and glycemic control.

Preparing for Discharge

If possible, institute the planned outpatient diabetes regimen prior to discharge to ensure adequate glycemic control and avoidance of hypoglycemia. Initiating new TZD therapy prior

to discharge is not useful because clinical benefit is not seen for several weeks. Because the patient may have been on multiple regimens while hospitalized, review discharge prescriptions and dosages thoroughly. Diabetes survival skills and sick day rules should be reviewed to ensure outpatient safety.

Whenever possible, follow-up appointments should be scheduled prior to discharge, and an emergency contact number should be provided in case problems arise. Offer a referral for diabetes self-management education and medical nutrition therapy after discharge if the patient has never had these services or if changes in health status or therapy occur.

© 2007 American College of Physicians, Inc. (ACP)

ACP reserves all rights not specifically granted by this license. Any modifications to license must be made by an authorized officer of ACP in writing. Requests for modifications may be sent to MKSAP® Permissions, ACP, 190 N. Independence Mall West, Philadelphia, PA 19106-1572.

Recipient of this publication is granted a nonexclusive, revocable, and transferable license to copy a particular chapter, form, patient education sheet, chart, or directory item from this publication for distribution to a medical associate, patient with diabetes, or family member of a patient with diabetes for educational purposes only. ACP may revoke or modify this license at anytime without notice to the recipient.

Recipient may not copy the entire publication, make derivative works, collective works, or compilations from this publication. Recipient may not copy or distribute any part of this publication for consideration. Recipient may not distribute any material from this publication via electronic transmission such as email, FTP, or HTTP. Recipient may not display any contents of this publication on any type of web page. This license terminates immediately if recipient fails to conform with any provision in this license agreement.

ISBN: 978-1-930513-91-4

Printed in the United States of America.

For information on this program in the United States or Canada, call 800-523-1546, extension 2600. Professionals from all other countries should call 215-351-2600 or send an email to custserv@acponline.org.

Educational Disclaimer

The editors and publisher of *ACP Diabetes Care Guide: A Team-Based Practice Manual and Self-Assessment Program* recognize that the development of new material offers many opportunities for error. Despite our best efforts, some errors may persist in print. Drug dosage schedules are, we believe, accurate and in accordance with current standards. Readers are advised, however, to ensure that the recommended dosages in this program concur with the information provided in the product information material. This is especially important in cases of new, infrequently used, or highly toxic drugs. Application of the information in the Guide in a professional situation remains the professional responsibility of the practitioner.

The primary purpose of the *ACP Diabetes Care Guide: A Team-Based Practice Manual and Self-Assessment Program* is educational. Information presented, as well as publications, technologies, products, and/or services discussed, is intended to inform subscribers about the knowledge, techniques, and experiences of the contributors. A diversity of professional opinion exists, and the views of the contributors are their own and not those of the ACP. Inclusion of any material in the Guide does not constitute endorsement or recommendation by the ACP. The ACP does not warrant the safety, reliability, accuracy, completeness or usefulness of and disclaims any and all liability for damages and claims that may result from the use of information, publications, technologies, products, and/or services discussed in this program.