

## Chapter

## 10

## SPECIAL SITUATIONS

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Several special situations exist in diabetes care, most importantly:

- ▲ Acute metabolic complications
- ▲ Hospitalization and surgery
- ▲ Dialysis
- ▲ Diabetes in pregnancy
- ▲ Treatment considerations related to patient age
- ▲ Diabetes care in people with disabilities

### ACUTE METABOLIC COMPLICATIONS

The acute metabolic complications of diabetes are<sup>1,2</sup>:

- ▲ Diabetic ketoacidosis (DKA)
- ▲ Hyperosmolar hyperglycemic state (HHS)
- ▲ Lactic acidosis (LA)
- ▲ Severe hypoglycemia

DKA and HHS are caused by insulin deficiency with or without decreased insulin sensitivity due to precipitating factors; lactic acidosis is typically associated with severe peripheral vascu-

lar disease, myocardial infarction (MI), heart failure, or sepsis, conditions that cause tissue hypoxia, increased anaerobic glycolysis, and hence overproduction of lactic acid. The most common precipitating factors leading to DKA, HHS, and LA are<sup>1,2</sup>:

- ▲ Infection
- ▲ Peripheral vascular disease/MI/heart failure
- ▲ Stroke
- ▲ Alcohol abuse
- ▲ Trauma
- ▲ Infection/sepsis/pancreatitis
- ▲ Medications such as steroids, diuretics, and certain antipsychotic agents

Initial DKA symptoms include polyuria, nausea, vomiting, and, particularly in children, abdominal pain. Lethargy or somnolence is a common later development. Presenting symptoms of HHS include hyperglycemia, extreme dehydration, and hyperosmolar plasma leading to impaired consciousness, sometimes accompanied by seizures.

### ***DKA and HHS***

DKA and HHS are life-threatening conditions that require hospitalization. Mortality rates are relatively high for these conditions—about 5% for DKA, 15% for HHS. Prompt diagnosis is critical. Table 10-1 illustrates diagnostic parameters. Note that clinicians should rule out starvation ketosis and alcoholic ketoacidosis as part of the diagnostic process.

### **Treatment guidelines for DKA**

The approach to treating DKA can be summarized as follows<sup>1</sup>:

- ▲ Bedside glucose monitoring should be performed at 1- to 2-hour intervals, laboratory measurements of electrolytes reviewed at 4-hour intervals.

**Table 10-1** Diagnostic Criteria for DKA and HHS

	DKA			HHS
	Mild	Moderate	Severe	
Plasma glucose (mg/dL)	>250	>250	>250	>600
Arterial pH	7.25–7.30	7.00–7.24	<7.00	>7.30
Serum bicarbonate (mEq/L)	15–18	10 to <15	<10	>15
Urine ketones <sup>a</sup>	Positive	Positive	Positive	Small
Serum ketones <sup>a</sup>	Positive	Positive	Positive	Small
Effective serum osmolality (mOsm/kg) <sup>b</sup>	Variable	Variable	Variable	>320
Anion gap <sup>c</sup>	>10	>12	>12	<12
Mental status	Alert	Alert/drowsy	Stupor/coma	Stupor/coma
3-Hydroxybutyrate (mmol/L)	3–5	5–12	>12	NA

Source: ADA, 2004.<sup>1</sup>

DKA, diabetic ketoacidosis; HHS, hyperosmolar hyperglycemic state.

<sup>a</sup>Nitroprusside reaction method.

<sup>b</sup>Calculation:  $2 \text{ [measured Na (mEq/L)]} + \text{glucose (mg/dL)}/18$ .

<sup>c</sup>Calculation:  $(\text{Na}^+) - (\text{Cl}^- + \text{HCO}_3^-)$  (mEq/L).

- ▲ Initiate fluid replacement therapy (usually isotonic saline) for expansion of first the intravascular volume and to restore renal perfusion. Give 1 L in the first half-hour and 1 L/h for an additional 1 to 2 hours until normal blood pressure is restored. Adjust according to intrinsic renal or heart disease. Thereafter, fluids may be changed to .45% saline and rate reduced to 150 to 250 mL/h to restore the rest of extracellular and intracellular volumes. Switch to dextrose-containing fluids when plasma or capillary glucose levels fall to 250 mg/dL.
- ▲ Begin insulin therapy as a continuous IV infusion at 7 to 10 U/h, and continue until glucose is 250 mg/dL. Decrease insulin infusion to 2U/h.
- ▲ When renal function is ensured, for serum potassium levels of <5.5 mEq/L add potassium chloride 10 to 30 mEq/h to fluid infusion to prevent hypokalemia.
- ▲ Acidosis will correct over time with insulin alone. Administration of NaHCO<sub>3</sub> is not recommended unless the acidosis is severe (ie, pH <6.9, HCO<sub>3</sub> <5 mEq/L) or leads to a clinical complication such as pulmonary edema, respiratory depression, or hyperkalemia. When rapid correction of acidosis is considered necessary, begin intravenous NaHCO<sub>3</sub> at 50 mEq/500 mL 0.45% saline over 30 to 60 minutes, with arterial pH checks after the infusion and repeated until the pH value reaches ≥7.1. More frequent monitoring of potassium levels and the empiric addition of 10 mEq KCl to each bicarbonate infusion is prudent.
- ▲ In patients with renal or cardiac compromise, monitor serum osmolality and frequently assess cardiac, renal, and mental status to avoid iatrogenic fluid overload.
- ▲ Consider phosphate replacement at 1 mmol/kg as potassium phosphate over 6 hours in patients with cardiac dysfunction, anemia, rhabdomyolysis, or respiratory depression, and in those with serum phosphate <1.0 mg/dL.

- ▲ To avoid cerebral edema, follow recommendations for gradual correction of glucose and osmolality, as well as use of isotonic or hypotonic saline, depending on serum sodium and the patient's hemodynamic status.
- ▲ Refer to guidelines for differing levels in pediatric patients

The criteria for resolution of DKA are as follows:

- ▲ Glucose <200 mg/dL
- ▲ Serum bicarbonate  $\geq 18$  mEq/L
- ▲ Venous pH >7.3
- ▲ 3-Hydroxybutyrate <1 mmol/L

When these levels are achieved, the guidelines outlined in Table 10-2 apply.

**Table 10-2** Treatment of Patients After DKA Resolution

Patient Characteristics	Treatment Guidelines
NPO (not eating)	<ul style="list-style-type: none"> <li>▲ Continue IV insulin and fluid replacement <i>or</i></li> <li>▲ Supplement with subcutaneous regular insulin as needed every 4 h</li> </ul>
Patients who can eat	<ul style="list-style-type: none"> <li>▲ Continue IV insulin regimen for 1 h after first subcutaneous injection to ensure adequate plasma insulin levels</li> <li>▲ Start basal/bolus regimen consisting of short-acting insulin before meals plus a basal insulin (NPH/glargine given at bedtime)</li> </ul>

Source: ADA, 2004.<sup>1</sup>

DKA, diabetic ketoacidosis; IV, intravenous; NPO, nothing per os (mouth).

## Management of HHS

- ▲ As in DKA, the initial goal is to expand intravascular volume, so 1 L 0.9% saline over 30 minutes is recommended. This should be repeated if the patient remains hypotensive; however, unlike DKA, there is a marked deficit in free water that should be corrected gradually to prevent plasma/CNS osmotic dysequilibrium. IV fluids should be changed to 0.45% saline once vascular perfusion pressure appears reasonable, at a rate of about 300 to 500 mL/h, adjusted on an hourly basis based on renal and cardiac output. With hydration alone, glucose levels will fall and sodium levels rise. When glucose level reaches <250 mg/dL, fluids should be switched to 5% dextrose in 0.45% saline or 5% dextrose in water if serum sodium is elevated (>155 mEq/L).
- ▲ Begin insulin therapy as a continuous IV infusion at 7 to 10 U/h.
- ▲ Bedside glucose monitoring should be performed at 1- to 2-hour intervals, and laboratory measurements of electrolytes reviewed at 4-hour intervals.
- ▲ Potassium depletion is often less severe in HHS. Careful repletion may be necessary, however. The addition of 10 mEq/L KCl to IV fluids is warranted to maintain normal plasma potassium.
- ▲ Bicarbonate treatment is not needed unless there is accompanying severe lactic acidosis.
- ▲ In patients with renal or cardiac compromise, monitor serum osmolality and frequently assess cardiac, renal, and mental status to avoid iatrogenic fluid overload.
- ▲ To avoid cerebral edema, follow recommendations for gradual correction of glucose and osmolality, as well as use of isotonic or hypotonic saline, depending on serum sodium and patient's hemodynamic status.

## Complications of DKA and HHS treatment

The most common complications of DKA and HHS treatment are outlined in Table 10-3.

### Lactic Acidosis

Lactic acidosis is characterized by the following diagnostic parameters<sup>2</sup>:

- ▲ Elevated lactic acid (lactic acidemia,  $\geq 2.0$  mmol/L)
- ▲ Acidosis (pH  $\leq 7.3$ )
- ▲ Normal or low levels of ketones ( $\leq 1:4$  on serum dilution, or  $\beta$ -hydroxybutyrate 0.4 to 0.6 mmol/L).

Cardiovascular compromise is a frequent finding, explaining many of the associated signs, which include cyanosis, cold extremities, tachycardia, hypotension, dehydration, hyperventilation or dyspnea, lethargy, stupor, or coma, vomiting, and/or abdominal pain.

**Table 10-3** Common Complications of Treatment for DKA and HHS

Complication	Cause
Hypoglycemia	Insulin overdosage
Hypokalemia	Severe potassium depletion; inadequate potassium repletion; insulin administration; treatment of acidosis with bicarbonate
Hyperglycemia; recurrent DKA	Interruption/discontinuance of insulin therapy without adequate subsequent use of subcutaneous insulin

Source: ADA, 2004.<sup>1</sup>

DKA, diabetic ketoacidosis; HHS, hyperosmolar hyperglycemic state.

Lactic acidosis is relatively uncommon, since one of its major precipitators, phenformin, a biguanide antidiabetic drug, was removed from the United States market. Metformin, also a biguanide, rarely causes lactic acidosis except when used in patients with significant renal impairment (creatinine clearance  $<40$  mL/min, serum creatinine  $>1.5$  mg/mL in men,  $>1.4$  mg/mL in women). It should be discontinued before elective surgery or before injecting radiocontrast agents. Today, the condition is relatively rare, typically occurring in severely ill patients with hypoxia due to MI, heart failure, renal failure, or septic shock.

Treatment of lactic acidosis involves treating the underlying precipitating condition and has the same basic parameters of treatment for DKA<sup>2</sup>, except that insulin is not routinely needed:

- ▲ Correction of shock and/or hypoxia
- ▲ Dialysis to remove metformin
- ▲ Hydration
- ▲ Restoration of electrolyte balance
- ▲ Correction of acidosis with sodium bicarbonate if needed and if not contraindicated by sodium and fluid overload
- ▲ Correction of hyperglycemia, if present, with insulin

### *Hypoglycemia*

Hypoglycemia as a result of diabetes treatment (via either insulin secretagogues or insulin) may occur based on any or a combination of the following factors<sup>2-4</sup>:

- ▲ Patient errors in insulin dosage or timing
- ▲ Delay in meals
- ▲ Changes in insulin regimens during attempts at intensive glycemic control (eg, multiple daily insulin injections)
- ▲ Comorbidities such as renal, hepatic, or pituitary insufficiency

- ▲ Overexertion (especially in combination with  $\beta$ -blockers)
- ▲ Excessive alcohol consumption
- ▲ Long duration of diabetes
- ▲ Hypoglycemia unawareness
- ▲ Older age (>60 years)
- ▲ Deterioration in glucose counterregulation

Hypoglycemic patients typically present with a combination of symptoms, depending on the seriousness of the condition<sup>3</sup>:

- ▲ Weakness
- ▲ Hunger
- ▲ Dizziness
- ▲ Pallor
- ▲ Headache
- ▲ Irritability
- ▲ Trembling
- ▲ Sweating
- ▲ Palpitations
- ▲ Sensation of cold
- ▲ Drowsiness
- ▲ Confusion
- ▲ Loss of consciousness
- ▲ Seizure

Table 10-4 highlights the degrees of hypoglycemic severity and strategies for treatment. Patients can reduce the risks of hypoglycemia with several measures<sup>2,3</sup>:

**Table 10-4**  
**Hypoglycemia Severity and Treatment Strategies**

Hypoglycemia Severity	Blood Glucose Levels (mg/dL)	Treatment	Special Considerations
Mild	60–70	Oral carbohydrates (12 g)	None
Moderate	50–60	Oral carbohydrates	Observe for improvement if possible
Severe	<50	Oral carbohydrates if patient's mental status permits; otherwise, IM glucose or glucagon	<p>Patients should be hospitalized until stabilized in the following circumstances:</p> <ul style="list-style-type: none"> <li>▶ Neuroglycopenia<sup>a</sup> (symptoms include coma, seizures, or altered behavior)</li> <li>▶ Blood glucose remains &lt;50 mg/dL and no prompt recovery of sensorium</li> <li>▶ Patient recovers but will be alone for the ensuing 12 h</li> <li>▶ Hypoglycemia was caused by a sulfonylurea</li> </ul>

Sources: NIDDK, 1995<sup>5</sup>; ADA, 2004.<sup>6</sup>

<sup>a</sup>Neuroglycopenia is a hypoglycemia-induced derangement of normal brain metabolism; if prolonged, it may result in permanent brain damage.

- ▲ Frequent self-monitored blood glucose (SMBG), ie  $\geq 3$  times/day
- ▲ Collaboration with the clinician or diabetes treatment team to arrive at individual, achievable glycemic targets
- ▲ Reduction in alcohol consumption
- ▲ Careful attention to insulin or sulfonylurea dosages, particularly in relation to anticipated meal times
- ▲ Monitoring and moderation of exercise with concordant adjustment of food intake or insulin dosage

### HOSPITALIZATION AND INPATIENT CARE

Patients with diabetes tend to require hospitalization more than twice as often, and for about 30% longer duration, than those without diabetes.<sup>5</sup> Admissions data reflect both the complications of diabetes and the effect of the disease on other conditions.

Patients should be considered for admission in any of the following circumstances so that clinicians can determine the causes and modify therapy<sup>6</sup>:

- ▲ Hyperglycemia with volume depletion
- ▲ Persistent refractory hyperglycemia with metabolic deterioration
- ▲ Recurrent fasting hyperglycemia ( $>300$  mg/dL) unresponsive to outpatient therapy, or A1C two times the upper limit of normal
- ▲ Recurrent severe hypoglycemia ( $<50$  mg/dL) despite intervention
- ▲ Metabolic instability involving swings between hypoglycemia ( $<50$  mg/dL) and fasting hyperglycemia ( $>300$  mg/dL)
- ▲ Recurrent DKA absent precipitating infection or trauma

- ▶ Repeated absence from school or work as a result of psychosocial problems that affect metabolic control and cannot be managed in the outpatient setting

Clinicians should also consider admitting patients with diabetes for a number of diabetes-related conditions<sup>6</sup>:

- ▶ Life-threatening acute metabolic complications, such as DKA, HHS, or severe hypoglycemia
- ▶ Newly diagnosed diabetes in children and adolescents
- ▶ Substantial and chronic poor metabolic control requiring monitoring, determination of etiology, and treatment modification
- ▶ Severe chronic diabetes complications, or unrelated severe conditions that are complicated by diabetes and affect metabolic control
- ▶ Uncontrolled or newly diagnosed pregnancy-related diabetes requiring insulin
- ▶ Institution of intensive-control regimens, including insulin pump therapy

Because diabetes can compound the effects of other conditions, patients with diabetes may be candidates for admission when nondiabetic patients with the same health issues—eg, infections, outpatient surgery, or chemotherapy—are not. In addition, chronic diabetes complications, such as nephropathy or cardiovascular disease (CVD), may progress to the point at which admission decisions should be guided by the status of the complication itself.<sup>6</sup>

### ***Diabetes Management in the Inpatient Setting***

Inpatient management of patients with diabetes presents special clinical challenges. Hyperglycemia in hospitalized patients often goes unrecognized and untreated, though it calls for timely correction and postdischarge evaluation. Significantly elevated A1C

levels suggest a hyperglycemia duration of at least 2 months, and indicate that hyperglycemia in the inpatient setting is due to more than situational stress.

Clinicians assessing hospitalized patients with diabetes should consider three primary issues:

- ▲ Diabetes type
- ▲ Nutritional status and requirements
- ▲ Glycemic goals

### Diabetes type

Whether a patient has type 1 or type 2 diabetes, and more specifically, whether or not the patient has the capacity of producing insulin, affects decisions about how inpatient glycemic goals are reached. Whereas patients with type 2 diabetes may not require insulin, if patients with type 1 diabetes have insulin withheld they will develop ketosis.

### Nutritional status and requirements

Most patients will be catabolic postoperatively or during illness. Adequate oral or parenteral nutrition becomes increasingly important as stress levels increase in severity or duration. Nutritional status, in order to determine ideal body weight and appropriate caloric intake given the underlying disease process, should be carefully assessed by the clinician. In most situations, this assessment may require a nutritional consultation in order to ascertain the needs.

Once the nutritional status is determined, hospitalized patients do require adequate insulin for optimal use of the calories they are given. Several considerations apply to the development of a nutritional plan:

- ▲ Patients with diabetes can tolerate several days of fasting if clinicians are careful to maintain their electrolyte balance and intravascular volume.

**Table 10-5** Estimating Ideal Body Weight in Hospitalized Patients With Diabetes\*

Patient sex	Weight/height	Adjustments
Female	100 lb. per 60 in. (45 kg/150 cm)	5 lb. (2.25 kg) for each additional inch (2.5 cm) of height
Male	106 lb. per 60 in. (47.7 kg/150 cm)	6 lb. (2.7 kg) for each additional inch (2.5 cm) of height

Source: Hamwi, 1964.<sup>32</sup>

\*These estimates are for medium-framed adults. Add 10% for larger-framed patients; subtract 10% for those with smaller frames.

- ▲ Liquid meals may substitute for or supplement solid foods, and come in several forms. Most offer roughly 1 kcal/mL with 50% to 75% of calories as carbohydrates.
- ▲ Parenteral nutrition should be considered if a fast of >5 days is likely, or if patients are malnourished and intolerant of enteral feeding.
- ▲ The carbohydrate load typically recommended for enteral or parenteral feeding is 3 to 5 mg glucose/kg/min.
- ▲ If hyperglycemia develops, the preferable corrective course is to initiate or adjust insulin therapy, rather than change the feeding formula or infusion rate.
- ▲ Insulin may be added to the parenteral mixture beginning with 0.1 U regular insulin per gram of carbohydrate per day. For patients already requiring insulin, clinicians can titrate a variable insulin infusion simultaneously using the parenteral preparation as a steady-state substrate. When the insulin requirement is identified, the insulin can be added to the parenteral mixture.

Patients resuming oral feeding after a fast typically begin with clear liquids, but clinicians should consider the purpose of the diet at this point when writing the diet order:

- ▲ If the resumption of oral intake is a test of enteral tolerance, and if the regimen includes insulin, a noncaloric liquid will serve.
- ▲ If resumption is expected to go smoothly, patients should receive liquids that include complex carbohydrates and protein. Caloric content may be estimated based on the initial evaluation.
- ▲ Clinicians should determine how an American Diabetes Association diet recommendations will be interpreted. In most hospitals, this includes three isocaloric meals and a bedtime snack; meals typically consist of 50% to 60% carbohydrate, 15% to 20% protein, and no more than 30% fat, with cholesterol held at <300 mg.
- ▲ The “exchange system,” by which a patient may make substitutions but only within a food group, offers advantages over more flexible approaches in terms of determining optimal subcutaneous insulin dose.
- ▲ Patients who are used to calculating their insulin dose based on a meal’s carbohydrate content should be encouraged to do so, under the supervision of the nursing staff and a registered dietician. In this case, oversight may allow an opportunity to evaluate the patient’s carbohydrate-counting skills and correct or advise if problems are identified.

### Glycemic goals

Outpatient glycemic goals may have to be relaxed somewhat for hospitalized patients due to several concerns, not least of which is the high risk associated with hypoglycemia in severely ill patients or in those with diminished cognitive function. In other cases, patients may require flexibility when insulin therapy is initiated

before discharge. Nevertheless, energy balance and wound healing benefit from normoglycemia if it can be maintained. The primary factors in setting goals are patient safety and the skill of the staff.

Glycemic control in the hospital setting can be affected by a variety of factors<sup>5</sup>:

- ▲ Day-to-day (up to 25%) and individual (up to 50%) variation in patient's insulin absorption rate
- ▲ Increased insulin needs due to pain and trauma, surgery, sepsis, burns, hypoxia, cardiovascular disease, and emotional stress secondary to the patient's counterregulatory stress response to illness
- ▲ Hospital methods for tracking blood glucose levels and adjusting medication dosages accordingly
- ▲ Issues related to meals (eg, the lack of a bedtime snack, or the lag time between preprandial insulin administration and meal consumption)
- ▲ Hospital formulary insulin that does not match the patient's usual type
- ▲ Use of narcotics, which can retard gut transit time, decrease glycemic control, and exacerbate existing diabetic constipation or gastroparesis

### Insulin therapy

Because hyperglycemia can increase the morbidity of acute illness and must be treated aggressively, insulin offers the best therapeutic choice for hospitalized patients due to its flexibility and quick action. Obviously, insulin given the intravenous route works immediately and is easily titrated. With IV insulin, effective levels can be achieved within minutes, making this approach the most responsive delivery method, particularly during the perioperative or intensive care setting.

There are several approaches to insulin protocols, but the following general considerations apply<sup>5,7-10</sup>:

- ▲ Guideline-directed orders (ie, insulin algorithms that consider dose, lag time, calorie load, time of day, and activity) should be used for both subcutaneous and IV insulin. These should replace sliding-scale insulin regimens, which base dosage on retrospective hyperglycemia and do not account for these variables.
- ▲ Patients' glycemia should be maintained high enough to decrease hypoglycemia risk ( $\geq 80$  mg/dL), but low enough to cut risk of excess catabolism, DKA, HHS, impaired leukocyte function, and poor wound healing ( $< 200$  mg/dL). These targets should be adapted as necessary for individual patients, particularly pregnant women and those with pancreas transplants (both cases dictating lower levels).

Intravenous insulin, regardless of the titration formula, requires a steady-state carbohydrate source. This may be via a simultaneous infusion of dextrose, a parenteral nutrition mixture, or even continuous enteral feeding. The "steady-state" infusion protocol involves arriving at an infusion rate using incremental increases of 0.5 U/h or decreases of 1.0 U/h, based on the patient's glycemic response, until the desired range is achieved (for inpatients, typically 90 to 120 mg/dL). This typically takes about 8 hours. This approach offers the advantage of using the patient's insulin sensitivity to determine the dose; its disadvantage is that due to its small incremental change, the protocol cannot respond well to drastic changes in insulin requirements such as those produced by administration of steroids or a concurrent catecholamine infusion.

Another protocol may be termed the "dynamic" protocol. In this protocol, the amount of insulin is calculated based on individual glucose measurements regardless of the prior rate. The formula for changed insulin is based on blood glucose (BG) and an insulin sensitivity factor. Regardless of which protocol is chosen, the decision to alter insulin is indeed based on observation of the patient and the glycemic response of the insulin given the current clinical situation. In this regard, individual dosing based on the demand is suggested. The formula is  $(\text{current BG} - \text{BG floor}) \times f = \text{U}$

regular insulin per hour, where  $f$  represents insulin sensitivity and is typically between 0.02-0.05 depending on the clinical status.

**Moving from IV to subcutaneous insulin** It is critically important that patients with diabetes—and particularly patients with type 1 diabetes—receive subcutaneous insulin before the IV infusion is terminated, but in many situations (eg, transfer out of intensive care unit [ICU]) this is overlooked. The result in patients with type 1 diabetes is typically ketoacidosis within 30 minutes of discontinuing the insulin infusion.

When patients are ready to move from IV to subcutaneous insulin, it is usually simplest to make the transition at mealtime with a subcutaneous injection 30 minutes before the meal if regular insulin is used, while continuing IV insulin (and dextrose) for 1 to 2 hours after the meal, at which point both infusions are stopped. This approach gives the patient a chance to absorb some insulin from the subcutaneous site before the infusion ends. Fast-acting insulin analogues reduce the problem of lag between insulin absorption from a subcutaneous injection and disappearance of IV insulin, but provision of a basal insulin source must be addressed.

Determining the optimal subcutaneous dosage is empirical, and in many cases patients who took subcutaneous insulin before admission may resume that dosage. However, some considerations apply:

- ▲ The patient's preadmission glycemic control
- ▲ The patient's appetite, and the degree to which the hospital diet approximates his/her diet at home
- ▲ The patient's stress levels related to hospitalization, including illness severity and pain

Clinicians can also estimate subcutaneous dosages based on infusion rates, per the guidelines in Table 10-6.

**Special considerations in insulin protocols** When arriving at a suitable insulin regimen, clinicians must take into account a

**Table 10-6** Subcutaneous Insulin Dosages Based on Patient Nutritional Status

Patient Nutritional Status	Subcutaneous Insulin Protocol
Minimal caloric intake (eg, 5% dextrose at 100 mL/h)	Total 24-h insulin should approximate basal needs or 50–60% of daily requirement when patient resumes eating; may be given as ultralente in two equal 12-h doses or glargine insulin as a single dose
Patient resumes eating	Continue as above, but add the remaining 40–50% of dosage as regular, lispro, or aspart insulin before each meal
Continuous tube feeding with titrated IV insulin, minimal voluntary intake	Same total daily dose as with the IV insulin infusion, divided as NPH or lente insulin every 8 h (tid); ultralente every 12 h (bid); or insulin glargine once daily

Source: Gebhart, 2000.<sup>33</sup>

patient's exposure to drugs that increase insulin requirements such as steroids, growth hormone, or catecholamines. In particular:

- ▲ Dexamethasone (daily) and hydrocortisone (=2 times per day) result in a reasonably stable pattern of insulin resistance.
- ▲ Prednisone usually has a peak effect on insulin requirements 8 to 12 hours after the oral dose, after which insulin resistance decreases. Patients taking prednisone in the morning often exhibit a clear diurnal variation in insulin requirements that entails an early-evening peak followed by a nadir before the next morning's dose.

Supplemental or “sliding scale” insulin protocols are usually discouraged by diabetes specialists but are still common in hospitals. The primary difficulty lies in how the approach is applied. Given that hospitalized patients frequently experience unpredictable changes in insulin requirements, a flexible insulin regimen based on glycemic level seems appropriate in principle. Problems typically occur when scheduled insulin doses are discontinued without considering the patient’s diabetes pathology, or when patients with a clear need for sustained insulin are managed with supplemental insulin alone.

***Patients with insulin pumps*** Patients accustomed to using insulin pumps may continue to use them while hospitalized, but nursing staff should inspect the infusion site and tubing and confirm that both basal and bolus insulin doses are as prescribed. Patients can calculate preprandial boluses using carbohydrate counting and record them for nutritionist review; nurses should confirm premeal BG levels and that the bolus was correctly delivered. This approach bolsters patient autonomy and provides safe supervision without unnecessarily burdening nursing staff.

In the perioperative or intensive care setting, it is generally preferable to administer insulin via an IV infusion; patients can later make the transition back to pump use when cleared to do so by their clinician.

***Overview of additional strategies for insulin therapy*** Table 10-7 outlines treatment strategies adapted to diabetes type and related patient profiles.

### **Specialists, teams, and education**

Evidence suggests that a diabetes team consisting of an endocrinologist and a nurse educator can shorten length of stay, improve glycemic control, and reduce readmission rates in patients with diabetes.<sup>11</sup> Such teams may also include a nutritionist and a social worker. With an eye toward early discharge planning, the team can work in the following ways:

**Table 10-7** Treatment Strategies for Management of Diabetic Inpatients

Patient Profile	Insulin/Glucose	Considerations
Type 1 NPO	Insulin drip matched with glucose	<ul style="list-style-type: none"> <li>▶ Use pumps due to small volumes required</li> <li>▶ Hourly bedside glucose monitoring</li> <li>▶ Continue drip during first light meal in case food is not tolerated</li> <li>▶ When food is tolerated, discontinue IV insulin and administer subcutaneously with normal lag time (if done before dinner, add bedtime or nighttime insulin doses to prevent AM hyperglycemia and ketosis)</li> </ul>
Eating	Subcutaneous insulin at least twice daily	<ul style="list-style-type: none"> <li>▶ Athletes, those near ideal body weight, and newly diagnosed patients may have lower requirements vs. sedentary or obese patients</li> <li>▶ Pubertal patients may require 1.0–1.5 U/kg due to physiologic insulin resistance</li> <li>▶ At a minimum, measure blood glucose before meals and bedtime (table continues)</li> </ul>

**Table 10-7**  
(continued)

Patient Profile	Insulin/Glucose	Considerations
Eating (cont)		<ul style="list-style-type: none"> <li>▶ Patients with preprandial blood glucose &gt;250 mg/dL should have urine ketones measured</li> <li>▶ Compensate with glucose in patients who must fast for radiographic procedures</li> </ul>
Type 2 Insulin-treated NPO	Insulin drip matched with glucose	<ul style="list-style-type: none"> <li>▶ Generally require higher insulin doses than patients with type 1 diabetes due to insulin resistance</li> <li>▶ If general anesthesia is required, use continuous IV insulin infusion</li> <li>▶ For brief, early procedures, insulin can usually be withheld until afterward, unless hyperglycemia is &gt;140 mg/dL</li> </ul>

Type 2  
Not insulin-  
treated  
NPO

- Continuous IV insulin/glucose infusion or oral agents
- ▶ Use IV infusion matched with glucose if blood glucose > 140 mg/dL
  - ▶ Oral agent may be OK in shorter fasting periods (<24 h), but monitor blood glucose carefully and use insulin if necessary; metformin should be discontinued prior to surgery

Type 2  
Insulin-treated  
Eating

- Similar to recommendations for patients with type 1 diabetes who are eating
- ▶ Some patients may be well controlled on NPH or once-daily insulin
  - ▶ If preprandial blood glucose > 120 mg/dL, use regular insulin or fast-acting analogue with appropriate lag time

Type 2  
Not insulin-  
treated  
Eating

- Preprandial insulin supplements, if indicated
- ▶ Explain to patients that they will probably not need to continue insulin after discharge

Source: Hirsch, 1995.<sup>5</sup>  
NPO, nothing by os (mouth).

- ▲ The endocrinologist can chart the patient's therapeutic course and also act as the team's ombudsman with medical staff and hospital administration.
- ▲ Team members can review the patient's glucose monitoring and insulin administration skills and address problems directly.
- ▲ If it becomes clear that the patient is not able to monitor BG or administer insulin adequately, team members can educate family members about these and other aspects of care and help arrange for in-home help after discharge.

The hospital setting presents both limitations and opportunities for educating patients with diabetes. Sick patients are unlikely to retain a great deal of information and the process is further disrupted by tests and other procedures. Nevertheless, as noted, the situation provides nurse educators and others with an opportunity to directly observe the patient's self-management skills and address problems. This type of personal interaction is likely to be much more effective than passive learning approaches using videos or lectures.

Team members should also aim to streamline the educational transition between hospital, home, and outpatient clinic settings. Although the patient may have trouble concentrating on written material while hospitalized, such materials are often helpful for family members and provide a reference for use after discharge. To help ensure a cohesive transition, diabetes educators should communicate with primary care clinicians and home care services to outline the patient's problem areas.

### **Surveillance of complications**

Because patients with diabetes may not be aware of the status of their complications it is often helpful to review them during hospitalization. Tests should include:

- ▲ A1C
- ▲ Fasting lipid profile

- ▲ Urine albumin (absent proteinuria on routine urinalysis); in the presence of proteinuria or abnormal albuminuria, a 24-hour urine collection may be appropriate
- ▲ Blood pressure
- ▲ Sensory deficits

Clinicians should discuss test results and their implications with the patient, but should do so at a time and in a manner appropriate to the patient's condition. They should also recapitulate this and other important information at discharge and recommend follow-up.

### **SURGICAL CARE**

Surgical patients with diabetes are at greater risk of morbidity and mortality, largely due to comorbidities such as cardiovascular disease and the metabolic abnormalities associated with the disease. Surgery may compound those abnormalities<sup>12</sup>:

- ▲ Anesthesia causes a neuroendocrine stress response (release of cortisol, growth hormone, catecholamines, and glucagon)
- ▲ Activation of the sympathetic nervous system and elevated epinephrine levels impair insulin secretion and cause insulin resistance; the counterregulatory response leads to hyperglycemia and excess catabolism (the magnitude of the latter affected by the severity of the surgery and its complications)
- ▲ Prolonged fasting and volume contraction associated with surgery contribute to metabolic decompensation
- ▲ Surgery-induced hyperglycemia is common and may progress to DKA; HHS is also common in patients with type 2 diabetes undergoing surgery

Because hyperglycemia inhibits leukocyte function, impairs wound healing, and may exacerbate ischemic brain damage, it is critical to maintain the best possible perioperative glycemic control in patients with diabetes undergoing surgery. Both metabolic

decompensation and these associated problems are best prevented by providing the patient with adequate insulin and fluids to counterbalance the catabolic response.

### ***Perioperative Care***

Before planned surgeries, clinicians should take the following steps:

- ▲ Assess the patient's metabolic control and establish the best possible levels
- ▲ Evaluate chronic diabetes complications that may affect surgical outcomes, particularly CVD and autonomic neuropathy
- ▲ In patients with type 2 diabetes, discontinue metformin the day before surgery and do not resume until renal function has been evaluated post-operatively and the patient is eating; other drugs may be continued up to the morning of surgery if glycemic control with these agents is acceptable. If glycemic control is poor, and if surgery is anticipated to be long or complicated, beginning IV insulin starting at least 2 hours before call to the operating room is preferable
- ▲ In patients with type 1 diabetes, administer insulin and glucose, as well as other fluids as indicated

In emergency surgeries, in addition to the steps just listed, clinicians should:

- ▲ Determine plasma glucose, urea, electrolyte concentrations, and blood pH
- ▲ Assess intravascular volume
- ▲ If patient has DKA, try to delay surgery to establish metabolic control
- ▲ Begin insulin infusion at appropriate rate (note that requirements may be increased)
- ▲ Begin glucose and potassium (if appropriate) infusion

- ▲ Infuse saline (if appropriate) to correct volume loss
- ▲ Check blood glucose (bedside) hourly; potassium every 4 hours

### Care During Surgery

The anesthesiologist should choose the anesthetic agent based on his or her preferences and the type of surgery, as no agents are specifically contraindicated in patients with diabetes. Table 10-8 outlines other considerations. Note that references to insulin imply a variety of insulin types or dosage levels based on the patient's history and the judgment of clinical staff.

**Table 10-8** Intraoperative Management of Patients with Diabetes

Patient Profile/ Anesthesia Type	Management Strategy
Type 1	
General	<ul style="list-style-type: none"> <li>▲ Give variable-rate insulin infusion</li> <li>▲ Give glucose infusion, fluids, and other requirements (eg, potassium) separately, as indicated</li> <li>▲ Carefully monitor patient's glycemic status (hourly before, during, and immediately after surgery), aiming for blood glucose 120–180 mg/dL</li> </ul>
Local	<ul style="list-style-type: none"> <li>▲ Consider subcutaneous insulin for some patients (eg, those undergoing short procedures); otherwise consider infusion</li> <li>▲ Administer glucose infusion if IV insulin is given</li> <li>▲ Monitor glycemic status hourly before, during, and immediately after surgery</li> </ul>

(table continues)

**Table 10-8** (continued)

Patient Profile/ Anesthesia Type	Management Strategy
Type 2	
General	<ul style="list-style-type: none"> <li>▲ If patient is well-controlled on diet therapy, only hourly blood glucose monitoring may be needed</li> <li>▲ Stop oral agents 24–72 h before surgery</li> <li>▲ Give variable-rate insulin infusion as needed to counteract surgery-induced hyperglycemia</li> <li>▲ Note that CABG may increase insulin needs; monitor glycemia frequently in such patients</li> <li>▲ Monitor glycemic status hourly before, during, and immediately after surgery</li> </ul>
Local	<ul style="list-style-type: none"> <li>▲ If patient is well-controlled on diet therapy, only hourly blood glucose monitoring may be needed</li> <li>▲ Stop sulfonylureas on the morning of surgery, metformin the day before surgery</li> <li>▲ Give variable-rate insulin infusion if indicated based on patient's metabolic status, usual regimen, expected interval until eating, and time of day</li> </ul>

Source: Marks and Hirsch, 1998.<sup>12</sup>

CABG, coronary artery bypass graft.

### Postoperative Care

Care of patients with diabetes after surgery should follow these guidelines:

- ▲ Continue variable-rate insulin infusion, measure BG (bed-side) every 1 to 2 hours until glycemic targets are met and food is tolerated
- ▲ Measure serum electrolytes immediately after surgery, then daily for those continuing on insulin infusion; identify and treat hyper- and hypokalemia
- ▲ If patient cannot tolerate food for >24 hours, measure urinary ketones daily

### **Outpatient Surgery**

Most of the above considerations also pertain to outpatient surgery. In addition:

- ▲ Patients should have specific guidelines for contacting their health care provider.
- ▲ Patients should self-monitor BG every 1 to 2 hours after returning home.
- ▲ Those taking insulin should leave the hospital with a plan for supplementation.
- ▲ Those controlled by diet or oral agents should contact the provider if BG rises above a certain level or if urine ketones are positive.
- ▲ Patients with nausea and vomiting should call their provider and be screened for ketones.
- ▲ Metformin should not be restarted until 48 hours after surgery; patients should have an interim insulin regimen.

### **DIALYSIS**

Patients with diabetes requiring dialysis have two options: hemodialysis and peritoneal dialysis. Table 10-9 outlines these approaches, including mention of dietary guidelines and considerations when choosing a method.

**Table 10-9** Dialysis Options and Considerations in Patients With Diabetes

Treatment	Options	Dietary Guidelines	Other Considerations
Hemodialysis	<ul style="list-style-type: none"> <li>▲ Home treatment</li> <li>▲ Dialysis-center treatment</li> </ul>	<ul style="list-style-type: none"> <li>▲ Eat balanced amounts of high-protein foods</li> <li>▲ Control potassium</li> <li>▲ Limit fluid intake</li> <li>▲ Avoid salt</li> <li>▲ Limit phosphorus-rich foods such as milk, cheese, nuts, dried beans, and dark colas</li> </ul>	<ul style="list-style-type: none"> <li>▲ Most common treatment (~80% of patients)</li> <li>▲ Requires 4–5 h treatment 3x/week</li> <li>▲ Requires placement of arteriovenous fistula</li> <li>▲ Home treatment offers more flexibility; outcomes may be slightly better</li> </ul>
	<ul style="list-style-type: none"> <li>▲ Home treatment, either CAPD or CCPD</li> </ul>	<ul style="list-style-type: none"> <li>▲ Limit salt and liquids, but not as stringently as with hemodialysis</li> <li>▲ Eat even more protein than for hemodialysis</li> <li>▲ Potassium restrictions may vary</li> <li>▲ Cut back overall calories if necessary to avoid weight gain</li> </ul>	<ul style="list-style-type: none"> <li>▲ CAPD does not require a machine; CCPD does</li> <li>▲ Makes traveling easier</li> <li>▲ Increases risk of peritonitis</li> <li>▲ Poorer survival rates vs hemodialysis</li> <li>▲ Gradual decrease in peritoneal surface area usually mandates a switch to hemodialysis within a few years</li> </ul>

CAPD, continuous ambulatory peritoneal dialysis; CCPD, continuous cycle-assisted peritoneal dialysis.

Sources: NIDDK, 2002<sup>34</sup>; Friedman, 1995, 1996.<sup>35, 36</sup>

## DIABETES AND PREGNANCY

Congenital fetal malformations increase as maternal glycemia is rising during the first 6 to 8 weeks of gestation and are the primary cause of fetal demise in infants in pregnancies complicated by either type 1 or type 2 diabetes. However, rates of malformation higher than the norm in nondiabetic pregnancies (1% to 2%) appear to be primarily associated with first-trimester A1C values  $>2$  standard deviations above the mean of a normal pregnant population of women.<sup>13,14</sup>

Because about two-thirds of women with diabetes have unplanned pregnancies, the care of those with childbearing potential should include:

- ▲ Education about the risk of malformations
- ▲ Effective contraceptive use

The specific goals of preconception care include<sup>13-15</sup>:

- ▲ Patient involvement in self-management, including appropriate plans for diet and exercise
- ▲ Achieving optimal glycemic control without undue hypoglycemia, including self-administered insulin and SMBG six times per day (before meals and 1 hour postprandially)
- ▲ Effective contraception, particularly in women who have not yet established adequate glycemic control
- ▲ Evaluation and treatment of diabetes complications, including pregnancy-induced hypertension, coronary artery disease, and other conditions that may be worsened by pregnancy or pose additional risks to the mother or fetus (eg, hypoglycemia)—specific assessments should include 24-hour urine for total protein, creatinine clearance, and microalbumin; thyroid function; nutritional status; retinal status; and cardiac function
- ▲ Discontinuation of angiotensin-converting enzyme (ACE) inhibitors and angiotensin receptor blockers (ARBs)

Management during pregnancy should include<sup>13-15</sup>:

- ▲ *Optimal glycemic control:* This should include A1C <6% (monitored every 1 or 2 months until stable); preprandial glucose target <90 mg/dL; 1-hour postprandial glucose target <120 mg/dL.
- ▲ *Retesting each trimester for thyroid function, kidney function, and retinal status:* Abnormalities dictate more frequent monitoring. Insulin requirements usually increase continuously throughout pregnancy, typically beginning with 0.7 U/kg of pregnant body weight per day (U/kg/day) during the first trimester, then progressing to 0.8 U/kg/day in the second trimester, 0.9 U/kg/day in the third trimester, and 1.0 U/kg/day at term. Postpartum requirements drop precipitously the first week postpartum and thereafter stabilize back to the prepregnant requirement of 0.6 U/kg/day. Patients with type 1 diabetes should then continue at this level (or the level determined as optimal by their clinicians), whereas patients with type 2 diabetes treated with oral agents before pregnancy should return to those drugs as soon as their infant is weaned.
- ▲ *Fetal monitoring:* Monitoring should begin at 35 weeks' gestation and includes ultrasound and fetal heart rate monitoring; decisions about delivery should be based on the well-being of both mother and fetus.

### **Gestational Diabetes Mellitus**

There are approximately 135,000 cases of gestational diabetes mellitus (GDM) annually in the US. GDM varies according to ethnic background and rates range from roughly 2% to 14% (the mean rate in the California Latino population is about 7%, for example). GDM is defined as glucose intolerance of variable degree with onset during pregnancy; women who have had GDM also face an increased risk of diabetes (usually type 2) after pregnancy.<sup>13,16</sup>

GDM is associated with increased risk of the following conditions<sup>15,16</sup>:

- ▲ Intrauterine fetal death during the last 4 to 8 weeks of pregnancy when hyperglycemia is untreated
- ▲ Fetal macrosomia
- ▲ Neonatal hypoglycemia, jaundice, erythremia, respiratory distress, and hypocalcemia
- ▲ Maternal hypertensive disorders

### Risk factor assessment and diagnosis

The primary risk factors for GDM are obesity, history of GDM, glycosuria, and strong family history of diabetes. Patients should be tested for GDM at first presentation when they are high risk and at 24 to 28 weeks gestation for moderate risk.

Beyond the usual diagnostic criteria for diabetes, GDM may be diagnosed one of two ways<sup>16</sup>:

- ▲ *One-step approach*: Diagnostic oral glucose tolerance test (OGTT)
- ▲ *Two-step approach*: Plasma or serum glucose 1 hour after a 50-g glucose load; diagnostic OGTT on those exceeding threshold values (>140 mg/dL identifies 80% of cases; >130 mg/dL identifies 90%)

Table 10-10 explains the OGTT diagnostic criteria for GDM.

### Monitoring and management

These approaches are appropriate for monitoring patients with GDM<sup>16,17</sup>:

- ▲ Daily SMBG (preprandial glucose target <90 mg/dL; 1-hour postprandial glucose target <120 mg/dL)
- ▲ Hypertension and urine protein monitoring (24-hour urine if BP >130/80 mm Hg)

**Table 10-10** OGTT Diagnostic Criteria for GDM\*

Test	mg/dL	mmol/L
100-g glucose load		
▲ Fasting	95	5.3
▲ 1-h	180	10.0
▲ 2-h	155	8.6
▲ 3-h	140	7.8
75-g glucose load		
▲ Fasting	95	5.3
▲ 1-h	180	10.0
▲ 2-h	155	8.6

Sources: ADA, 2004<sup>16</sup>; Jovanovic, 2001.<sup>15</sup>

OGTT, oral glucose tolerance test; GDM, gestational diabetes mellitus.

\* Two or more of the venous plasma concentrations must be met or exceeded for a positive diagnosis for fasting.

- ▲ Fetal status with ultrasound and/or fetal heart rate monitoring if pregnancy develops any indicators of poor glycemic control or elevated BP

Patients may be managed as follows<sup>15,16,18</sup>:

- ▲ Begin nutritional counseling (medical nutritional therapy [MNT]).
- ▲ In obese women (>150% of ideal body weight), a 30% to 33% carbohydrate distribution of calories (total 18 to 24 kcal/kg/day) may reduce hyperglycemia.
- ▲ Insulin may be added to MNT when indicated by glycemic control; doses to be guided by SMBG. The new insulin analogues lispro and aspart have been proved safe for GDM.

Insulin glargine has not been studied in human pregnancies.

- ▲ Measurement of fetal abdominal circumference early in the third trimester may rule out excess macrosomia risk.
- ▲ Institute appropriate exercise regimen.
- ▲ Delivery (induced or cesarean) should be undertaken past 40 weeks; consider earlier delivery if there are signs of fetal distress.
- ▲ Assess mother's glycemic status postdelivery and at yearly follow-ups thereafter. Refer for family-planning clinic follow-up evaluation as well.

Table 10-11 outlines appropriate thresholds for beginning insulin therapy in GDM patients who cannot maintain adequate glycemic control with MNT. Some clinicians recommend lower levels than those in Table 10-11:

- ▲ Fasting whole BG  $\leq 90$  mg/dL
- ▲ 1-hour postprandial whole BG  $\leq 120$  mg/dL

**Table 10-11** Thresholds for Beginning Insulin Therapy

Test	mg/dL	mmol/L
Fasting whole BG	$\geq 95$	5.3
Fasting PG	$\geq 105$	5.8
1-h postprandial whole BG	$\geq 140$	7.8
1-h postprandial PG	$\geq 155$	8.6
2-h postprandial whole BG	$\geq 120$	6.7
2-h postprandial PG	$\geq 130$	7.2

Source: ADA, 2004.<sup>16</sup>

BG, blood glucose; PG, plasma glucose.

## MNT for diabetes during pregnancy

Proper diet during pregnancy is vital to fetal growth and development and maternal health in all women, and more so in women with diabetes, either preexisting or gestational. Hormonal changes and weight gain during pregnancy adversely affect metabolic homeostasis. Oral medications used to treat diabetes are not approved for use during pregnancy, elevating the importance of MNT. Recommendations for weight gain in pregnancy complicated by existing or gestational diabetes are found in Table 10-12.

### **PATIENT AGE**

Treating diabetes in children, adolescents, and the elderly carries special challenges. This section outlines considerations and guidelines that pertain to each patient group.

#### ***Children and Adolescents***

Because about 75% of type 1 diabetes incidence occurs in children under 18 years of age, clinicians must integrate their care of this population with the complex emotional and physical needs of the patients and their families. The goal of near-normal glycemia may be more difficult to achieve if individual preferences and family dynamics are not taken into consideration.

As a result, the treatment team should address issues in the following areas when making care decisions and recommendations:

- ▲ Medical
- ▲ Educational
- ▲ Nutritional
- ▲ Behavioral

#### **Younger children**

Children should clearly understand the goals of care and become involved in self-management to the greatest extent possible. In addition, special considerations apply<sup>13,20</sup>:

**Table 10-12** Weight-Gain Recommendations for Pregnant Women With Preexisting Diabetes or Women with Gestational Diabetes Mellitus

Body Type	Daily cal/lb of Prepregnancy Weight (an additional 150–300 cal/day in 2nd and 3rd trimesters)	Recommended Weight Gain (lb)
Underweight (BMI <19.8)	16–18	28–40
Normal weight (BMI 19.8–26)	14	25–35
Overweight (BMI 26–29)	11	15–25
Obese (BMI > 29)	Not >1,800 cal/day	15
Multiples		
Twins	▲ Additional 150 cal/day above singleton pregnancy or amount consistent with targeted weight gain	35–45
Triplets	▲ Additional 150–300 cal/day in 2nd and 3rd trimester	45–55

Source: Joslin Diabetes Center, 2002.<sup>19</sup>  
BMI, body mass index.

- ▲ Children younger than 6 or 7 years may be unaware of hypoglycemia; moreover, they may suffer brain damage and other complications due to it.

- ▲ Younger children are more susceptible to intercurrent illnesses; as a result, sick-day rules should emphasize assessment for ketosis and severe hyperglycemia.
- ▲ Children and parents should be provided with guidelines for MNT at diagnosis; however, overaggressive dietary manipulation should be avoided in the very young.
- ▲ Schools and day-care providers have responsibilities to ensure the child's safety, including supplies to treat hypoglycemia, personnel training in practices such as BG monitoring and administration of insulin and glucagon, and emergency phone numbers. Parents should provide the facilities with supportive information as needed.

### Adolescents

Parents and providers must consider adolescent patients' complex psychosocial needs and how they may contribute to an unwillingness to adhere to treatment plans. Caregivers should work with families to consider behavioral and emotional needs, then resolve problems and modify goals as indicated.

### Type 2 diabetes in children and adolescents

As type 2 diabetes prevalence is increasing in the young, clinicians need to understand the special needs of these patients to develop treatment regimens that suit them. Again, the ideal goal is near-normalization of glycemia, initially with nutrition therapy and exercise, then later with oral agents or insulin if indicated. Most juvenile patients develop diabetes after puberty, possibly due to the insulin resistance associated with adolescence.<sup>13,21</sup> Table 10-13 presents an outline for testing for pediatric type 2 diabetes.

Following are the preferred treatment choices for children and adolescents with type 2 diabetes<sup>21,22</sup>:

- ▲ Patients should be taught about the importance of MNT and exercise; those who are not ill at diagnosis may be managed with these approaches alone at first.

**Table 10-13** Testing for Pediatric Type 2 Diabetes

Criteria<sup>a</sup>

- ▲ Overweight (BMI >85th percentile for age and sex; weight for height >85th percentile; weight >120% of ideal for height)

Plus any two of the following risk factors:

- ▲ Family history of type 2 diabetes in a first- or second-degree relative
- ▲ Race/ethnicity (American Indians, African Americans, Hispanic Americans, Asians/South Pacific Islanders)
- ▲ Signs of or conditions associated with insulin resistance (acanthosis nigricans, hypertension, dyslipidemia, polycystic ovarian syndrome)

Age of initiation

- ▲ Age 10 years or at onset of puberty if puberty occurs earlier

Frequency

- ▲ Every 2 years

Test

- ▲ FPG preferred

Source: ADA, 2000.<sup>21</sup>

BMI, body mass index; FPG, fasting plasma glucose.

<sup>a</sup>Use clinical judgment to test high-risk patients who do not meet these criteria.

- ▲ Those with greatly elevated blood glucose—or with symptoms such as dehydration, ketosis, or acidosis—should be considered for initial treatment with insulin.
- ▲ Patients should receive comprehensive self-management education, including instruction on the importance of SMBG—particularly among those on insulin or sulfonylureas—including both fasting and postprandial measurements.

- ▲ Clinicians should monitor patients' A1C at intervals appropriate to ensure adequate evaluation of glycemic control.
- ▲ Metformin is the oral agent of first choice, and is currently the only one that has been studied in adolescents in randomized trials.<sup>22</sup> Metformin is contraindicated in patients with impaired renal function, liver disease, hypoxemia, severe infections, or alcohol abuse.
- ▲ If monotherapy with metformin fails in 3 to 6 months, other agents (eg, sulfonylureas or insulin) may be added.
- ▲ Patients should receive dilated eye examinations and screening for microalbuminuria at least annually.
- ▲ Hypertension should be treated; ACE inhibitors are the agent of first choice.
- ▲ Dyslipidemia should be treated; weight loss, improved glycemic control, and exercise may be enough to improve the profile adequately. Statins are contraindicated in pregnant women and should not be prescribed for females of childbearing potential without adequate counseling and effective contraception.

Children and adolescents at risk (ie, those with impaired glucose tolerance/impaired fasting glucose) should begin aggressive diet and exercise regimens to forestall progression to clinical diabetes.

### **Care for Older Adults**

About 10% of people over age 65 have diabetes—and 44% of patients with diabetes are over 65. As a result, clinicians need to be aware of the disease's interaction with other health problems as well as treatment goals unique to this population.<sup>13,33</sup>

The following considerations apply<sup>13,23</sup>:

- ▲ Those likely to live long enough to enjoy reduced complication rates may benefit from tight glycemic control.

- ▲ By contrast, patients with severe complications (eg, renal insufficiency), cognitive impairment, or shorter projected life spans may reasonably set less strict glycemic goals—especially given that they are more prone to the serious consequences of hypoglycemia. For such patients, reasonable targets are FPG <140 mg/dL and postprandial glucose <220 mg/dL. Other contraindications to tight control include cirrhosis, alcoholism, autonomic nerve dysfunction, and physical disability with social isolation or food restriction.
- ▲ CV risk reduction (eg, antihypertensive treatment) is as important as in younger patients.
- ▲ Exercise is important to whatever extent possible.

### Diagnostic and treatment challenges in the elderly

Older patients pose specific diagnostic and treatment challenges<sup>23</sup>:

- ▲ Lack of thirst perception may result in little or no polydipsia but increased risk of hyperosmolar states.
- ▲ Polyuria may appear as incontinence or as a prostate-related problem.
- ▲ Altered perception of hypoglycemia may lead to serious problems—but should not be an excuse for failing to treat hyperglycemia.
- ▲ Diabetic complications are compounded due to the effects of aging on many of the same systems (eg, kidneys, eyes, blood vessels, nerves).
- ▲ Increasing rates of concurrent illnesses may worsen other symptoms of diabetes.
- ▲ More frequent and severe foot problems make careful screening critical.

## Drug regimens in older patients

Clinicians can treat older patients with diabetes with the same pharmaceutical therapies as younger patients, but must carefully monitor their status. Table 10-14 outlines considerations that apply.

### **DIABETES CARE IN PATIENTS WITH DISABILITIES**

Patients with diabetes often experience significant disabilities. The long-term complications of diabetes—cardiovascular disease, renal disease, neuropathy and its associated foot problems, pain, visual impairment, depression, and so forth—create special challenges for patients and clinicians.

One study<sup>24</sup> found that among patients over 60 years old with diabetes, 32% of women and 15% of men reported an inability to walk a quarter of a mile, climb stairs, or do housework—roughly twice the percentage of age-matched controls without diabetes (14% of women and 8% of men). Of the more than 5 million US adults aged 60 years or older with diabetes, roughly

**Table 10-14** Considerations in Drug Therapy for Older Patients

Drug or Drug Type	Contraindication and/or Consideration
Metformin	Renal insufficiency or heart failure
Insulin secretagogues (eg, sulfonylureas)	Hypoglycemia
Insulin	Hypoglycemia; requires adequate cognitive skills
Thiazolidinediones	Congestive heart failure
$\alpha$ -Glucosidase inhibitors	May not be well-tolerated; may not be effective as monotherapy

Source: ADA, 2004.<sup>13</sup>

1.2 million were estimated to be unable to perform these or similar physical tasks. Coronary heart disease was a major contributing factor to disability in both men and women, and stroke contributed strongly in men.

Other research has demonstrated that patients with diabetes with neuropathy had significantly poorer performance scores in tests of walking speed, balance, and coordination versus both non-diabetic controls and patients with diabetes without neuropathy.<sup>25,26</sup>

In many cases, treatment for the disabilities associated with diabetes is similar to treatment of these problems in patients without diabetes. For example, a patient with diabetes who has had a foot amputated due to neuropathy and peripheral vascular disease requires the same follow-up care, including treatment by a prosthetist or orthotist, as will an amputee without diabetes. Patients receiving rehabilitation after an MI or a stroke will have similar needs regardless of their glycemic status.

Sometimes patients with diabetes do require special consideration, as with those who have psychosocial issues or physical or visual impairment.

### ***Psychosocial Issues***

Diabetes' physical comorbidities can lead to psychosocial problems. For example, patients who are depressed about recurrent foot ulcers may neglect self-care. Patients with diabetes complications are more likely to report problems with their jobs, families, recreation, and social lives than those without complications, and patients with A1C >9.3% rate their physical and emotional status significantly lower than those with A1C <9.3%. About 25% of patients with diabetes experience depression, and many who are treated successfully experience not only improved psychological well-being but also better glycemic control.<sup>27</sup>

Table 10-15 illustrates a variety of common psychosocial problems related to diabetes and suggested ameliorative approaches.

### ***Physical Problems***


An important strategy to help patients with diabetes-related disabilities take care of themselves successfully is to encourage their own

**Table 10-15** Psychosocial Problems in Diabetes and Potential Interventions

Problem	Treatment
Stress and anxiety	Behavior therapy, relaxation training, EMG biofeedback, medication
Poor self-care	Improved cues and reinforcement, behavior therapy, medication if related to depression
Obesity	Behavior therapy
Smoking	Behavior therapy, smoking cessation assistive devices, medications
Alcohol abuse	Cognitive behavioral therapy, Alcoholics Anonymous or similar programs, medication
Depression	Antidepressant medication, cognitive-behavioral therapy, interpersonal therapy
Poor social support	Individual and family therapy, diabetes support groups

Source: Aikens and Lustman, 2001.<sup>27</sup>  
EMG, electromyographic.

creative problem-solving and independence, even if they have strong support from friends and family.<sup>28</sup> Assistive technology (AT) offers a variety of approaches that can significantly improve daily life for disabled patients with diabetes; for example<sup>29</sup>:

-  **Computers:** If properly adapted, computers can allow previously unemployable disabled people to enter the workforce. Large-screen displays, screen-reading software, on-screen touch-sensitive controls, modified keyboards, specialized control devices, voice-recognition software, and related innovations can help those with visual, auditory, or motor impairments to remain productive.

- ▲ *Synthetic speech software*: Software lets blind patients do self-monitoring of blood glucose by reading their glucose monitor findings aloud. Devices so outfitted can also read watches and clocks, thermostats, thermometers, scales, microwave ovens, calculators, organizers, and so forth. Braille devices can perform many of the same functions.
- ▲ *Text telephones (TTYs)*: TTYs offer communication opportunities for those with impaired hearing.

### Patients with visual impairment

Because retinopathy, macular edema, and related problems are more prevalent in people with diabetes than in those without diabetes, it is important that clinicians are able to guide their patients to a variety of helpful approaches, including blindness rehabilitation when appropriate. Clinicians should also determine which patients will be able to perform tasks visually (usually those with vision better than 20/100) and which will need to develop non-visual skills. This should be undertaken bearing in mind that patients' vision may fluctuate. An initial assessment should include:

- ▲ Functional low vision
- ▲ Nonvisual sensory limitations (eg, those that might impair a patient's ability to substitute tactile devices or cues for visual ones)
- ▲ Memory

Patient self-management education should cover<sup>30,31</sup>:

- ▲ Blood glucose monitoring
- ▲ Medication and insulin management
- ▲ Record-keeping
- ▲ Nutrition management
- ▲ Foot care
- ▲ Exercise

**Blood glucose monitoring** A variety of methods are available to help visually impaired patients self-monitor their blood glucose.

- ▲ As noted, some monitors accept speech software that will audibly read out the blood glucose level.
- ▲ Patients who retain some vision may be able to read their results on large-screen video monitors.
- ▲ Getting an adequate blood sample and making it available to the glucose monitor may be particularly difficult for visually impaired patients. Various tactile methods may be helpful, as are meters that audibly signal that an adequate sample has been applied.
- ▲ Patients should be taught to clean the meter routinely if they can't see well enough to judge for themselves.

**Measuring insulin** The following options can help patients measure insulin doses:

- ▲ Those with reliable low vision may only need better lighting, contrasting colors, or a magnifier. A magnifier that rests on the chest is particularly helpful as it leaves patients' hands free.
- ▲ Preset dose gauges measure the space between the syringe barrel and the plunger.
- ▲ A measuring device that holds the insulin vial and syringe can be preset for one or two doses, although a sighted helper must set the doses.
- ▲ Variable-dose devices use clicks to measure insulin for single and mixed doses.
- ▲ A variety of insulin pens measure insulin in 1- or 2-unit increments.

- ▲ Some needleless injectors offer tactile and auditory cues for determining doses.
- ▲ Some visually impaired patients can use insulin pumps.

**Other medications** Although most blind people can recognize a limited number of their medications by size and shape, those who take many pills, or who take similar ones, need to devise ways to avoid confusion. One way is to store the pills in containers of varying sizes and shapes; another is to make tactile labels using file folder labels and dimensional fabric paint; a third is to store medications on different shelves or different parts of the house. A sighted person can fill medication boxes, such as Medisets, on a weekly basis.

**Record-keeping** Patients who retain some vision can usually keep records with thick markers on white paper, sometimes with the help of magnifiers. Those who are functionally blind need other methods such as Braille, audiotape, or a voice- and audio-adapted computer.

**Nutrition management** Blind patients will need to learn nonvisual methods of food measurement such as nesting measuring cups or food scales with an audible readout. They may also wish to obtain cups, glasses, and bowls that are the correct size for common portions. Thick, high paint can be used to mark cooking devices such as ovens and ranges to help prevent accidents.

**Foot care** Visual impairment can increase the danger of foot complications because patients may be less adept at avoiding hazards while walking and are often unable to adequately inspect their feet. Patients may be able to use magnifying mirrors to see their feet, or they may use nonvisual inspection methods such as the following:

- ▲ Touch
- ▲ Smell
- ▲ Temperature perception

Those who cannot successfully use these methods will require the assistance of a sighted person to inspect their feet.

**Exercise** Although many forms of exercise remain available to the visually impaired patient, some considerations apply:

- ▲ Those with proliferative retinopathy must be careful to preserve their remaining vision. As a result, they should avoid exercises that increase both systolic blood pressure and intraocular pressure. These include bending over so that the head is lower than the waist, Valsalva-type maneuvers that raise blood pressure, isometric or weight training, vigorous bouncing such as found in high-impact aerobics, rapid head movements, and recreation that involves extreme changes in surrounding pressure such as skydiving or scuba diving.
- ▲ Exercise routines should include a warm-up, aerobic activity, and a cool-down. Stretches should be done without lowering the head below the heart. Examples of safe and effective exercises for visually impaired patients with diabetes include walking, swimming, and tandem bicycle riding. Patients whose visual impairment is relatively new, and who have previously enjoyed a particular athletic activity, should be encouraged to continue it with necessary adaptations if at all possible.

Clinicians may find referrals to occupational or physical therapists invaluable to assist persons with diabetes and disabilities to adapt to their disabilities and perform self-care both safely and successfully.

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