15. Diabetes Care in the Hospital: *Standards of Medical Care in Diabetes—2020*

American Diabetes Association

Among hospitalized patients, both hyperglycemia and hypoglycemia are associated with adverse outcomes, including death (1–4). Therefore, careful management of inpatients with diabetes has direct and immediate benefits. Hospital management of diabetes is facilitated by preadmission treatment of hyperglycemia in patients having elective procedures, a dedicated inpatient diabetes service applying well-developed standards, and careful transition out of the hospital to prearranged outpatient management. These steps can shorten hospital stays and reduce the need for readmission, as well as improve patient outcomes. Some in-depth reviews of hospital care for patients with diabetes have been published (5,6).

HOSPITAL CARE DELIVERY STANDARDS

Recommendations

15.1 Perform an A1C test on all patients with diabetes or hyperglycemia (blood glucose >140 mg/dL [7.8 mmol/L]) admitted to the hospital if not performed in the prior 3 months. **B**

15.2 Insulin should be administered using validated written or computerized protocols that allow for predefined adjustments in the insulin dosage based on glycemic fluctuations. **C**

Considerations on Admission

High-quality hospital care for diabetes requires standards for care delivery, which are best implemented using structured order sets, and quality assurance for process improvement. Unfortunately, "best practice" protocols, reviews, and guidelines (2) are inconsistently implemented within hospitals. To correct this, medical centers striving for optimal inpatient diabetes treatment should establish protocols and structured order sets, which include computerized physician order entry (CPOE).

Initial orders should state the type of diabetes (i.e., type 1, type 2, gestational diabetes mellitus, pancreatic diabetes) when it is known. Because inpatient treatment and discharge planning are more effective if based on preadmission glycemia, an A1C should be measured on all patients with diabetes or hyperglycemia admitted to the hospital if the test has not been performed in the previous 3 months (7–10). In addition, diabetes self-management knowledge and behaviors should be assessed on admission and diabetes self-management education provided, if appropriate. Diabetes self-management education should include appropriate skills needed after discharge, such as medication dosing and administration, glucose monitoring, and recognition and treatment of hypoglycemia (2). There is evidence to support preadmission treatment of hyperglycemia in patients scheduled for elective surgery as an effective means of reducing adverse outcomes (11–13).

The National Academy of Medicine recommends CPOE to prevent medication-related errors and to increase efficiency in medication administration (14). A Cochrane review of randomized controlled trials using computerized advice to improve glucose control in the hospital found significant improvement in the percentage of time patients spent in the target glucose range, lower mean blood glucose levels, and no increase in hypoglycemia (15). Thus, where feasible, there should be structured order sets that provide computerized advice for glucose control. Electronic insulin order templates also improve mean glucose levels without increasing hypoglycemia in patients with type 2 diabetes, so structured insulin order sets should be incorporated into the CPOE (16,17).

Diabetes Care Providers in the Hospital

Recommendation

15.3 When caring for hospitalized patients with diabetes, consult with a specialized diabetes or glucose management team when possible. **C**

Appropriately trained specialists or specialty teams may reduce length of stay, improve glycemic control, and improve outcomes (11,18,19). In addition, the greater risk of 30-day readmission following hospitalization that has been attributed to diabetes can be reduced, and costs saved, when inpatient care is provided by a specialized diabetes management team (20,21). In a cross-sectional comparison of usual care to management by specialists who reviewed cases and made recommendations solely through the electronic medical record, rates of both hyper- and hypoglycemia were reduced 30–40% by electronic "virtual care" (22). Details of team formation are available in The Joint Commission Standards for programs and from the Society of Hospital Medicine (23,24).

Even the best orders may not be carried out in a way that improves quality, nor are they automatically updated when new evidence arises. To this end, the Joint Commission has an accreditation program for the hospital care of diabetes (23), and the Society of Hospital Medicine has a workbook for program development (24).

GLYCEMIC TARGETS IN HOSPITALIZED PATIENTS

Recommendations

15.4 Insulin therapy should be initiated for treatment of persistent hyperglycemia starting at a threshold ≥180 mg/dL (10.0 mmol/L). Once insulin therapy is started, a target glucose range of 140–180 mg/dL (7.8–10.0 mmol/L) is recommended for the majority of critically ill patients and non-critically ill patients. **A**

15.5 More stringent goals, such as 110–140 mg/dL (6.1–7.8 mmol/L), may be appropriate for selected patients if they can be achieved without significant hypoglycemia. **C**

Standard Definitions of Glucose Abnormalities

Hyperglycemia in hospitalized patients is defined as blood glucose levels >140 mg/dL (7.8 mmol/L) (2,25). Blood glucose levels persistently above this level should prompt conservative interventions, such as alterations in diet or changes to medications that cause hyperglycemia. An admission A1C value ≥6.5% (48 mmol/mol) suggests that the onset of diabetes preceded hospitalization (see Section 2 "Classification and Diagnosis of Diabetes," https://doi.org/10.2337/dc20-S002) (2,25). Hypoglycemia in hospitalized patients is categorized by blood glucose concentration and clinical correlates (**Table 6.4**) (26): Level 1 hypoglycemia is a glucose concentration 54–70 mg/dL (3.0–3.9 mmol/L). Level 2 hypoglycemia is a blood glucose concentration <54 mg/dL (3.0 mmol/L), which is typically the threshold for neuroglycopenic symptoms. Level 3 hypoglycemia is a clinical event characterized by altered mental and/or physical functioning that requires assistance from another person for recovery. Levels 2 and 3 require immediate correction of low blood glucose.

Glycemic Targets

In a landmark clinical trial, Van den Berghe et al. (27) demonstrated that an intensive intravenous insulin regimen to reach a target glycemic range of 80–110 mg/dL (4.4–6.1 mmol/L) reduced mortality by 40% compared with a standard approach targeting blood glucose of 180–215 mg/dL (10–12 mmol/L) in critically ill patients with recent surgery (4). This study provided robust evidence that active treatment to lower blood glucose in hospitalized patients had immediate benefits. However, a large, multicenter follow-up study, the Normoglycemia in Intensive Care Evaluation and Survival Using Glucose Algorithm Regulation (NICE-SUGAR) trial (28), led to a reconsideration of the optimal target range for glucose lowering in critical illness. In this trial critically ill patients randomized to intensive glycemic control (80–110 mg/dL) derived no significant treatment advantage compared with a group with more moderate glycemic targets (140–180 mg/dL [7.8–10.0 mmol/L]) and in fact had slightly but significantly higher mortality (27.5% vs. 25%). The intensively treated group had 10- to 15-fold greater rates of hypoglycemia, which may have contributed to the adverse outcomes noted. The findings from NICE-SUGAR are supported by several meta-analyses, some of which suggest that tight glycemic control increases mortality compared with more moderate glycemic targets and generally causes higher rates of hypoglycemia (29–31). Based on these results, insulin therapy should be initiated for treatment of persistent hyperglycemia ≥180 mg/dL (10.0 mmol/L) and targeted to a glucose range of

140–180 mg/dL (7.8–10.0 mmol/L) for the majority of critically ill patients (2). Although not as well supported by data from randomized controlled trials, these recommendations have been extended to hospitalized patients without critical illness. More stringent goals, such as 110–140 mg/dL (6.1–7.8 mmol/L), may be appropriate for selected patients (e.g., critically ill postsurgical patients or patients with cardiac surgery), as long as they can be achieved without significant hypoglycemia. On the other hand, glucose concentrations >180 mg/dL (10 mmol/L) may be acceptable in terminally ill patients, in patients with severe comorbidities, and in inpatient care settings where frequent glucose monitoring or close nursing supervision is not feasible. In these patients less aggressive insulin regimens to minimize glucosuria, dehydration, and electrolyte disturbances are often more appropriate. Clinical judgment combined with ongoing assessment of clinical status, including changes in the trajectory of glucose measures, illness severity, nutritional status, or concomitant medications that might affect glucose levels (e.g., glucocorticoids), should be incorporated into the day-to-day decisions regarding insulin dosing (2).

BEDSIDE BLOOD GLUCOSE MONITORING

In hospitalized patients with diabetes who are eating, glucose monitoring should be performed before meals; in those not eating, glucose monitoring is advised every 4–6 h (2). More frequent blood glucose testing ranging from every 30 min to every 2 h is the required standard for safe use of intravenous insulin. Safety standards for blood glucose monitoring that prohibit the sharing of lancets, other testing materials, and needles are mandatory (32).

The vast majority of hospital glucose monitoring is performed using standard glucose monitors and capillary blood taken from fingersticks, similar to the process used by outpatients for home glucose monitoring (33). Point-of-care (POC) meters are not as accurate or as precise as laboratory glucose analyzers, and capillary blood glucose readings are subject to artifact due to perfusion, edema, anemia/erythrocytosis, and several medications commonly used in the hospital (4,34). The U.S. Food and Drug

Administration (FDA) has established standards for capillary (fingerstick) blood glucose meters used in the ambulatory setting, as well as standards to be applied for POC measures in the hospital (34). The balance between analytic requirements (e.g., accuracy, precision, interference) and clinical requirements (rapidity, simplicity, point of care) has not been uniformly resolved (33,35), and most hospitals/medical centers have arrived at their own policies to balance these parameters. It is critically important that devices selected for in-hospital use, and the work flow through which they are applied, have careful analysis of performance and reliability and ongoing quality assessments. Recent studies indicate that POC measures provide adequate information for usual practice, with only rare instances where care has been compromised (36,37). Good practice dictates that any glucose result that does not correlate with the patient's clinical status should be confirmed through measurement of a serum sample in the clinical laboratory.

Continuous Glucose Monitoring

Real-time continuous glucose monitoring (CGM) provides frequent measurements of interstitial glucose levels, as well as direction and magnitude of glucose trends. It has theoretical advantages over POC glucose testing in detecting and reducing the incidence of hypoglycemia in the hospital setting that have been borne out in some but not all studies (38,39). Several inpatient studies have shown that CGM use did not improve glucose control but detected a greater number of hypoglycemic events than POC glucose testing (40,41). However, at present, there are insufficient data on clinical outcomes, safety, or cost effectiveness to recommend widespread use of CGM in hospitalized patients (38,40). In particular, more research is needed to support application of CGM for critical care (41). In patients who use CGM in the ambulatory setting for self-management of diabetes, use of CGM for this purpose during hospitalization can be appropriate but requires hospitals to have protocols for guidance, as well as access to specialist care (39). For more information on CGM, see Section 7 "Diabetes Technology" (https://doi.org/10 .2337/dc20-S007).

GLUCOSE-LOWERING TREATMENT IN HOSPITALIZED PATIENTS

Recommendations

15.6 Basal insulin or a basal plus bolus correction insulin regimen is the preferred treatment for noncritically ill hospitalized patients with poor oral intake or those who are taking nothing by mouth. **A** An insulin regimen with basal, prandial, and correction components is the preferred treatment for noncritically ill hospitalized patients with good nutritional intake. **A**

15.7 Use of only a sliding scale insulin regimen in the inpatient hospital setting is strongly discouraged. **A**

In most instances, insulin is the preferred treatment for hyperglycemia in hospitalized patients (2). However, in certain circumstances, it may be appropriate to continue home regimens including oral glucose-lowering medications (42). If oral medications are held in the hospital, there should be a protocol for resuming them 1–2 days before discharge. For patients using insulin, recent reports indicate that inpatient use of insulin pens is safe and may be associated with improved nurse satisfaction compared with the use of insulin vials and syringes (43–45). Insulin pens have been the subject of an FDA warning because of potential blood-borne diseases; the warning "For single patient use only" should be rigorously followed (46).

Insulin Therapy

Critical Care Setting

In the critical care setting, continuous intravenous insulin infusion is the most effective method for achieving glycemic targets. Intravenous insulin infusions should be administered based on validated written or computerized protocols that allow for predefined adjustments in the infusion rate, accounting for glycemic fluctuations and insulin dose (2).

Noncritical Care Setting

Outside of critical care units, scheduled insulin regimens are recommended to manage hyperglycemia in patients with diabetes. Regimens using insulin analogs and human insulin result in similar glycemic control in the hospital setting (47). The use of subcutaneous rapid- or short-acting insulin before meals, or every 4–6 h if no

meals are given or if the patient is receiving continuous enteral/parenteral nutrition, is indicated to correct hyperglycemia (2). Basal insulin, or a basal plus bolus correction regimen, is the preferred treatment for noncritically ill hospitalized patients with poor oral intake or those who are restricted from oral intake. An insulin regimen with basal, prandial, and correction components is the preferred treatment for noncritically ill hospitalized patients with good nutritional intake.

For patients who are eating, insulin injections should align with meals. In such instances, POC glucose testing should be performed immediately before meals. If oral intake is poor, a safer procedure is to administer prandial insulin immediately after the patient eats, with the dose adjusted to be appropriate for the amount ingested (47).

A randomized controlled trial has shown that basal-bolus treatment improved glycemic control and reduced hospital complications compared with reactive, or sliding scale, insulin regimens (i.e., dosing given in response to elevated glucose rather than pre-emptively) in general surgery patients with type 2 diabetes (48). Prolonged use of sliding scale insulin regimens as the sole treatment of hyperglycemic inpatients is strongly discouraged (2,19).

While there is evidence for using premixed insulin formulations in the outpatient setting (49), a recent inpatient study of 70/30 NPH/regular insulin versus basal-bolus therapy showed comparable glycemic control but significantly increased hypoglycemia in the group receiving premixed insulin (50). Therefore, premixed insulin regimens are not routinely recommended for in-hospital use.

Type 1 Diabetes

For patients with type 1 diabetes, dosing insulin based solely on premeal glucose levels does not account for basal insulin requirements or caloric intake, increasing the risk of both hypoglycemia and hyperglycemia. Typically, basal insulin dosing schemes are based on body weight, with some evidence that patients with renal insufficiency should be treated with lower doses (51,52). An insulin regimen with basal and correction components is necessary for all hospitalized patients with type 1 diabetes, with the addition of prandial insulin if the patient is eating.

Transitioning Intravenous to Subcutaneous Insulin

When discontinuing intravenous insulin, a transition protocol is associated with less morbidity and lower costs of care (53) and is therefore recommended. A patient with type 1 or type 2 diabetes being transitioned to an outpatient subcutaneous regimen should receive a dose of subcutaneous basal insulin 2–4 h before the intravenous infusion is discontinued. Converting to basal insulin at 60–80% of the daily infusion dose is an effective approach (2,53,54). For patients transitioning to regimens with concentrated insulin (U-200, U-300, or U-500) in the inpatient setting, it is important to ensure correct dosing by utilizing an individual pen and cartridge for each patient and by meticulous supervision of the dose administered (55,56). New studies support the use of closed-loop insulin delivery with linked pump/sensor devices to control blood glucose in selected groups of hospitalized patients with type 2 diabetes (57,58). The effect of closed-loop treatment on clinical outcomes, the best application of these devices, and cost-effectiveness of this approach are still to be determined.

Noninsulin Therapies

The safety and efficacy of noninsulin glucose-lowering therapies in the hospital setting is an area of active research (59). Several recent randomized trials have demonstrated the potential effectiveness of glucagon-like peptide 1 receptor agonists and dipeptidyl peptidase 4 inhibitors in specific groups of hospitalized patients (60–63). However, an FDA bulletin states that providers should consider discontinuing saxagliptin and alogliptin in people who develop heart failure (64).

Sodium–glucose transporter 2 (SGLT2) inhibitors should be avoided in cases of severe illness, in patients with ketonemia or ketonuria, and during prolonged fasting and surgical procedures (5). Until safety and effectiveness are established, SGLT2 inhibitors are not recommended for routine in-hospital use.

HYPOGLYCEMIA

Recommendations

15.8 A hypoglycemia management protocol should be adopted and implemented by each hospital or hospital system. A plan for preventing and treating hypoglycemia should be established for each patient. Episodes of hypoglycemia in the hospital should be documented in the medical record and tracked. **E**

15.9 The treatment regimen should be reviewed and changed as necessary to prevent further hypoglycemia when a blood glucose value of <70 mg/dL (3.9 mmol/L) is documented. **C**

Patients with or without diabetes may experience hypoglycemia in the hospital setting. While hypoglycemia is associated with increased mortality (65), in many cases it is a marker of underlying disease rather than the cause of fatality. However, hypoglycemia is a severe consequence of dysregulated metabolism and/or diabetes treatment, and it is imperative that it be minimized in hospitalized patients. Many episodes of hypoglycemia among inpatients are preventable. Therefore, a hypoglycemia prevention and management protocol should be adopted and implemented by each hospital or hospital system. A standardized hospital-wide, nurse-initiated hypoglycemia treatment protocol should be in place to immediately address blood glucose levels of <70 mg/dL (3.9 mmol/L). In addition, individualized plans for preventing and treating hypoglycemia for each patient should also be developed. An American Diabetes Association (ADA) consensus statement recommends that a patient's treatment regimen be reviewed any time a blood glucose value of <70 mg/dL (3.9 mmol/L) occurs, because such readings often predict subsequent level 3 hypoglycemia (2). Episodes of hypoglycemia in the hospital should be documented in the medical record and tracked (2).

Triggering Events and Prevention of Hypoglycemia

Insulin is one of the most common drugs causing adverse events in hospitalized patients, and errors in insulin dosing and/or administration occur relatively frequently (66,67). Beyond insulin dosing errors, common preventable sources of iatrogenic hypoglycemia are improper prescribing of other glucose-lowering medications, inappropriate management of the first episode of hypoglycemia, and nutrition-insulin mismatch, often related

to an unexpected interruption of nutrition. A recent study describes acute kidney injury as an important risk factor for hypoglycemia in the hospital (68), possibly as a result of decreased insulin clearance. Studies of "bundled" preventive therapies, including proactive surveillance of glycemic outliers and an interdisciplinary data-driven approach to glycemic management, showed that hypoglycemic episodes in the hospital could be prevented. Compared with baseline, two such studies found that hypoglycemic events fell by 56–80% (69,70). The Joint Commission recommends that all hypoglycemic episodes be evaluated for a root cause and the episodes be aggregated and reviewed to address systemic issues (23).

In addition to errors with insulin treatment, iatrogenic hypoglycemia may be induced by a sudden reduction of corticosteroid dose, reduced oral intake, emesis, inappropriate timing of short- or rapid-acting insulin in relation to meals, reduced infusion rate of intravenous dextrose, unexpected interruption of enteral or parenteral feedings, and altered ability of the patient to report symptoms (5).

Predictors of Hypoglycemia

In ambulatory patients with diabetes, it is well established that an episode of severe hypoglycemia increases the risk for a subsequent event, in part because of impaired counterregulation (71,72). This relationship also holds for inpatients. For example, in a study of hospitalized patients treated for hyperglycemia, 84% who had an episode of "severe hypoglycemia" (defined as <40 mg/dL [2.2 mmol/L]) had a preceding episode of hypoglycemia (<70 mg/dL [3.9 mmol/L]) during the same admission (73). In another study of hypoglycemic episodes (defined as <50 mg/dL [2.8 mmol/L]), 78% of patients were using basal insulin, with the incidence of hypoglycemia peaking between midnight and 6:00 A.M. Despite recognition of hypoglycemia, 75% of patients did not have their dose of basal insulin changed before the next insulin administration (74).

Recently, several groups have developed algorithms to predict episodes of hypoglycemia among inpatients (75,76). Models such as these are potentially important and, once validated for general use, could provide a valuable tool to reduce rates of hypoglycemia in hospitalized patients.

MEDICAL NUTRITION THERAPY IN THE HOSPITAL

The goals of medical nutrition therapy in the hospital are to provide adequate calories to meet metabolic demands, optimize glycemic control, address personal food preferences, and facilitate creation of a discharge plan. The ADA does not endorse any single meal plan or specified percentages of macronutrients. Current nutrition recommendations advise individualization based on treatment goals, physiological parameters, and medication use. Consistent carbohydrate meal plans are preferred by many hospitals as they facilitate matching the prandial insulin dose to the amount of carbohydrate consumed (77). For enteral nutritional therapy, diabetes-specific formulas appear to be superior to standard formulas in controlling postprandial glucose, A1C, and the insulin response (78).

When the nutritional issues in the hospital are complex, involvement of a registered dietitian nutritionist can contribute to patient care by integrating information about the patient's clinical condition, meal planning, and lifestyle habits and by establishing realistic treatment goals after discharge. Orders should also indicate that the meal delivery and nutritional insulin coverage should be coordinated, as their variability often creates the possibility of hyperglycemic and hypoglycemic events.

SELF-MANAGEMENT IN THE HOSPITAL

Diabetes self-management in the hospital may be appropriate for specific patients (79,80). Candidates include both adolescent and adult patients who successfully conduct self-management of diabetes at home, and whose cognitive and physical skills needed to successfully self-administer insulin and perform self-monitoring of blood glucose are not compromised. In addition, they should have adequate oral intake, be proficient in carbohydrate estimation, use multiple daily insulin injections or continuous subcutaneous insulin infusion (CSII), have stable insulin requirements, and understand sick-day management. If self-management is to be used, a protocol should include a requirement that the patient, nursing staff, and physician agree that patient self-management is appropriate. If CSII or CGM is to be used, hospital policy and procedures delineating guidelines for CSII therapy, including the changing of infusion sites, are advised (39,81).

STANDARDS FOR SPECIAL SITUATIONS

Enteral/Parenteral Feedings

For patients receiving enteral or parenteral feedings who require insulin, the regimen should include coverage of basal, prandial, and correctional needs. It is particularly important that patients with type 1 diabetes continue to receive basal insulin even if feedings are discontinued. A reasonable estimate of basal needs can be made from the preadmission dose of long-acting or intermediate insulin or a percentage of the total daily requirements established in the hospital (usually 30–50% of the total daily dose of insulin). In the absence of previous insulin dosing, a reasonable starting point is to use 5 units of NPH/detemir insulin subcutaneously every 12 h or 10 units of insulin glargine every 24 h (82).

For patients receiving continuous tube feedings, the total daily nutritional component may be calculated as 1 unit of insulin for every 10–15 g carbohydrate per day or as a percentage of the total daily dose of insulin when the patient is being fed (usually 50–70% of the total daily dose of insulin). Correctional insulin should also be administered subcutaneously every 6 h using human regular insulin or every 4 h using a rapid-acting insulin such as lispro, aspart, or glulisine.

For patients receiving enteral bolus feedings, approximately 1 unit of regular human insulin or rapid-acting insulin per 10–15 g carbohydrate should be given subcutaneously before each feeding. Correctional insulin coverage should be added as needed before each feeding.

For patients receiving continuous peripheral or central parenteral nutrition, human regular insulin may be added to the solution, particularly if >20 units of correctional insulin have been required in the past 24 h. A starting dose of 1 unit of human regular insulin for every 10 g dextrose has been recommended (83), and should be adjusted daily in the solution. Correctional insulin should be administered subcutaneously. For full enteral/parenteral feeding guidance, the reader is encouraged to consult review articles detailing this topic (2,84).

Glucocorticoid Therapy

The prevalence of glucocorticoid therapy in hospitalized patients can approach 10%, and these medications can induce hyperglycemia in patients with and without antecedent diabetes (85). Glucocorticoid type and duration of action must be considered in determining insulin treatment regimens. Daily ingestion of short-acting glucocorticoids such as prednisone reach peak plasma levels in 4–6 h (86) but have pharmacologic actions that last through the day. Patients on morning steroid regimens have disproportionate hyperglycemia during the day, but they frequently reach normal blood glucose levels overnight regardless of treatment (85). In subjects on once-daily steroids, prandial insulin dosing, often with intermediate-acting (NPH) insulin, is a standard approach. For long-acting glucocorticoids such as dexamethasone and multidose or continuous glucocorticoid use, long-acting insulin may be required to control fasting blood glucose (42,84). For higher doses of glucocorticoids, increasing doses of prandial and correctional insulin, sometimes in extraordinary amounts, are often needed in addition to basal insulin (87). Whatever orders are started, adjustments based on anticipated changes in glucocorticoid dosing and POC glucose test results are critical.

Perioperative Care

Many standards for perioperative care lack a robust evidence base. However, the following approach (88) may be considered:

1. The target range for blood glucose in the perioperative period should be 80–180 mg/dL (4.4–10.0 mmol/L).
2. A preoperative risk assessment should be performed for patients with diabetes who are at high risk for ischemic heart disease and those with autonomic neuropathy or renal failure.
3. Metformin should be withheld on the day of surgery.
4. Withhold any other oral glucose-lowering agents the morning of surgery or procedure and give half of NPH dose or 60–80% doses of long-acting analog or pump basal insulin.
5. Monitor blood glucose at least every 4–6 h while patient is taking nothing by mouth and dose with short- or rapid-acting insulin as needed.

A recent review concluded that perioperative glycemic control tighter than 80–180 mg/dL (4.4–10.0 mmol/L) did not improve outcomes and was associated with more hypoglycemia (89); therefore, in general, tighter glycemic targets are not advised. Evidence from a recent study indicates that compared with usual dosing, a reduction of insulin given the evening before surgery by ~25% was more likely to achieve perioperative blood glucose levels in the target range with lower risk for hypoglycemia (90).

In noncardiac general surgery patients, basal insulin plus premeal short- or rapid-acting insulin (basal-bolus) coverage has been associated with improved glycemic control and lower rates of perioperative complications compared with the reactive, sliding scale regimens (short- or rapid-acting insulin coverage only with no basal insulin dosing) (48,91).

Diabetic Ketoacidosis and Hyperosmolar Hyperglycemic State

There is considerable variability in the presentation of diabetic ketoacidosis (DKA) and hyperosmolar hyperglycemic states, ranging from euglycemia or mild hyperglycemia and acidosis to severe hyperglycemia, dehydration, and coma; therefore, individualization of treatment based on a careful clinical and laboratory assessment is needed (92–95).

Management goals include restoration of circulatory volume and tissue perfusion, resolution of hyperglycemia, and correction of electrolyte imbalance and acidosis. It is also important to treat any correctable underlying cause of DKA such as sepsis, myocardial infarction, or stroke. In critically ill and mentally obtunded patients with DKA or hyperosmolar hyperglycemia, continuous intravenous insulin is the standard of care. Successful transition of patients from intravenous to subcutaneous insulin requires administration of basal insulin 2–4 h prior to the intravenous insulin being stopped to prevent recurrence of ketoacidosis and rebound hyperglycemia (95). There is no significant difference in outcomes for intravenous human regular insulin versus subcutaneous rapid-acting analogs when combined with aggressive fluid management for treating mild or moderate DKA (96). Patients with uncomplicated DKA may sometimes be treated with subcutaneous insulin in the emergency department or step-

down units (97), an approach that may be safer and more cost-effective than treatment with intravenous insulin (98). If subcutaneous insulin administration is used, it is important to provide adequate fluid replacement, frequent bedside testing, appropriate treatment of any concurrent infections, and appropriate follow-up to avoid recurrent DKA. Several studies have shown that the use of bicarbonate in patients with DKA made no difference in resolution of acidosis or time to discharge, and its use is generally not recommended (99). For further information regarding treatment, refer to recent in-depth reviews (5).

TRANSITION FROM THE HOSPITAL TO THE AMBULATORY SETTING

> **Recommendation**
> **15.10** There should be a structured discharge plan tailored to the individual patient with diabetes. **B**

A structured discharge plan tailored to the individual patient may reduce length of hospital stay and readmission rates and increase patient satisfaction (100). Discharge planning should begin at admission and be updated as patient needs change.

Transition from the acute care setting presents risks for all patients. Inpatients may be discharged to varied settings, including home (with or without visiting nurse services), assisted living, rehabilitation, or skilled nursing facilities. For the patient who is discharged to home or to assisted living, the optimal program will need to consider diabetes type and severity, effects of the patient's illness on blood glucose levels, and the patient's capacities and preferences. See Section 12 "Older Adults" (https://doi.org/10.2337/dc20-S012) for more information.

An outpatient follow-up visit with the primary care provider, endocrinologist, or diabetes educator within 1 month of discharge is advised for all patients experiencing hyperglycemia in the hospital. If glycemic medications are changed or glucose control is not optimal at discharge, an earlier appointment (in 1–2 weeks) is preferred, and frequent contact may be needed to avoid hyperglycemia and hypoglycemia. A recently described discharge algorithm for glycemic medication adjustment based on admission A1C was found useful to

guide treatment decisions and significantly improved A1C after discharge (8). Therefore, if an A1C from the prior 3 months is unavailable, measuring the A1C in all patients with diabetes or hyperglycemia admitted to the hospital is recommended.

Clear communication with outpatient providers either directly or via hospital discharge summaries facilitates safe transitions to outpatient care. Providing information regarding the cause of hyperglycemia (or the plan for determining the cause), related complications and comorbidities, and recommended treatments can assist outpatient providers as they assume ongoing care.

The Agency for Healthcare Research and Quality (AHRQ) recommends that, at a minimum, discharge plans include the following (101):

Medication Reconciliation
- The patient's medications must be cross-checked to ensure that no chronic medications were stopped and to ensure the safety of new prescriptions.
- Prescriptions for new or changed medication should be filled and reviewed with the patient and family at or before discharge.

Structured Discharge Communication
- Information on medication changes, pending tests and studies, and follow-up needs must be accurately and promptly communicated to outpatient physicians.
- Discharge summaries should be transmitted to the primary care provider as soon as possible after discharge.
- Scheduling follow-up appointments prior to discharge increases the likelihood that patients will attend.

It is recommended that the following areas of knowledge be reviewed and addressed prior to hospital discharge:

- Identification of the health care provider who will provide diabetes care after discharge.
- Level of understanding related to the diabetes diagnosis, self-monitoring of blood glucose, home blood glucose goals, and when to call the provider.
- Definition, recognition, treatment, and prevention of hyperglycemia and hypoglycemia.

- Information on making healthy food choices at home and referral to an outpatient registered dietitian nutritionist to guide individualization of meal plan, if needed. If relevant, when and how to take blood glucose–lowering medications, including insulin administration.
- Sick-day management.
- Proper use and disposal of needles and syringes.

It is important that patients be provided with appropriate durable medical equipment, medications, supplies (e.g., blood glucose test strips), and prescriptions along with appropriate education at the time of discharge in order to avoid a potentially dangerous hiatus in care.

PREVENTING ADMISSIONS AND READMISSIONS

In patients with diabetes, the hospital readmission rate is between 14% and 20%, nearly twice that in patients without diabetes (102,103). This reflects increased disease burden for patients and has important financial implications. Of patients with diabetes who are hospitalized, 30% have two or more hospital stays, and these admissions account for over 50% of inpatient costs for diabetes (104). Factors contributing to readmission include male sex, longer duration of prior hospitalization, number of previous hospitalizations, number and severity of comorbidities, and lower socioeconomic and/or educational status; scheduled home health visits and timely outpatient follow-up reduce rates of readmission (102,103). While there is no standard to prevent readmissions, several successful strategies have been reported (103). These include targeting ketosis-prone patients with type 1 diabetes (105), insulin treatment of patients with admission A1C >9% (75 mmol/mol) (106), and use of a transitional care model (107). For people with diabetic kidney disease, collaborative patient-centered medical homes may decrease risk-adjusted readmission rates (108). A recently published algorithm based on patient demographic and clinical characteristics had only moderate predictive power but identifies a promising future strategy (109).

Age is also an important risk factor in hospitalization and readmission among patients with diabetes. Insulin-treated

patients 80 years of age or older are more than twice as likely as those 45–64 years of age to visit the emergency department and nearly five times as likely to be admitted for insulin-related hypoglycemia (110). One approach to reducing insulin-related morbidity in older adults with type 2 diabetes is to substitute oral agents for insulin in patients in whom these drugs are effective. Among elderly patients in long-term care facilities, there was no significant difference in glycemic control between those taking basal insulin and those on oral glucose-lowering medications (111). In addition, many older adults with diabetes are overtreated (112), with half of those maintaining an A1C <7% (53 mmol/mol) being treated with insulin or a sulfonylurea, which are associated with hypoglycemia. To further lower the risk of hypoglycemia-related admissions in older adults, providers should consider relaxing A1C targets to 8% (64 mmol/mol) or 8.5% (69 mmol/mol) in patients with shortened life expectancies and significant comorbidities (refer to Section 12 "Older Adults," https://doi.org/10.2337/dc20-S012, for detailed criteria).

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