



# 16. Diabetes Care in the Hospital: Standards of Medical Care in Diabetes—2022

American Diabetes Association  
Professional Practice Committee\*

*Diabetes Care* 2022;45(Suppl. 1):S244–S253 | <https://doi.org/10.2337/dc22-S016>

The American Diabetes Association (ADA) “Standards of Medical Care in Diabetes” includes the ADA’s current clinical practice recommendations and is intended to provide the components of diabetes care, general treatment goals and guidelines, and tools to evaluate quality of care. Members of the ADA Professional Practice Committee, a multidisciplinary expert committee (<https://doi.org/10.2337/dc22-SPPC>), are responsible for updating the Standards of Care annually, or more frequently as warranted. For a detailed description of ADA standards, statements, and reports, as well as the evidence-grading system for ADA’s clinical practice recommendations, please refer to the Standards of Care Introduction (<https://doi.org/10.2337/dc22-SINT>). Readers who wish to comment on the Standards of Care are invited to do so at [professional.diabetes.org/SOC](https://professional.diabetes.org/SOC).

Among hospitalized patients, hyperglycemia, hypoglycemia, and glucose variability are associated with adverse outcomes, including death (1–3). 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 (3–5). For older hospitalized patients or for patients in the long-term care facilities, please see Section 13, “Older Adults” (<https://doi.org/10.2337/dc22-S013>).

## HOSPITAL CARE DELIVERY STANDARDS

### Recommendations

- 16.1** 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**
- 16.2** Insulin should be administered using validated written or computerized protocols that allow for predefined adjustments in the insulin dosage based on glycemic fluctuations. **B**

### 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 (2–4) 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).

\*A complete list of members of the American Diabetes Association Professional Practice Committee can be found at <https://doi.org/10.2337/dc22-SPPC>.

Suggested citation: American Diabetes Association Professional Practice Committee. 16. Diabetes care in the hospital: Standards of Medical Care in Diabetes—2022. *Diabetes Care* 2022;45(Suppl. 1):S244–S253

© 2021 by the American Diabetes Association. Readers may use this article as long as the work is properly cited, the use is educational and not for profit, and the work is not altered. More information is available at <https://diabetesjournals.org/journals/pages/license>.

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 for all patients with diabetes or hyperglycemia admitted to the hospital if the test has not been performed in the previous 3 months (6–9). 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 (2,3). There is evidence to support preadmission treatment of hyperglycemia in patients scheduled for elective surgery as an effective means of reducing adverse outcomes (10–13).

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

**16.3** 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 the length

of stay, improve glycemic control, and improve outcomes (10,18,19). 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

- 16.4** Insulin therapy should be initiated for treatment of persistent hyperglycemia starting at a threshold  $\geq 180$  mg/dL (10.0 mmol/L) (checked on two occasions). 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 and noncritically ill patients. **A**
- 16.5** 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) (2,3,25). 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  $\geq 6.5\%$  (48 mmol/mol) suggests that the onset of diabetes preceded hospitalization (see Section 2, “Classification and Diagnosis of Diabetes,” <https://doi.org/10.2337/dc22-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. 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  $\geq 180$  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. 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 (32,33). On the other hand, glucose concentrations between 180 mg/dL and 250 mg/dL (10–13.9 mmol/L) may be acceptable in patients with severe comorbidities and in inpatient care settings where frequent glucose monitoring or close nursing supervision is not feasible. Glycemic levels above 250 mg/dL (13.9 mmol/L) may be acceptable in terminally ill patients with short life expectancy. 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 (34).

### BEDSIDE BLOOD GLUCOSE MONITORING

In hospitalized patients with diabetes who are eating, bedside glucose monitoring should be performed before meals; in those not eating, glucose monitoring is advised every 4–6 h (2). More frequent bedside 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 (35).

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 (36). 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 (37). 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 (37). The balance between analytic requirements (e.g., accuracy, precision, interference) and clinical requirements (rapidity, simplicity, point of care) has not been uniformly resolved (36,38), 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 workflow 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 (39,40). 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 the direction and magnitude of glucose trends. Even though CGM has theoretical advantages over POC glucose testing in detecting and reducing the incidence of hypoglycemia, it has not been approved by the FDA for inpatient use. Some hospitals with established glucose management teams allow the use of CGM in selected patients on an individual basis, provided both the patients and the glucose management team are well educated in the use of this technology. CGM is not approved for intensive care unit use.

During the COVID-19 pandemic, several institutions used CGM to minimize contact between health care providers and patients, especially those in the intensive care unit (41–49). This approach seems to be helpful in that regard, as well as helping to minimize the use of personal protective equipment. Unfortunately, the data about the use of CGM to improve either glycemic control or hospitalization outcomes are not yet available. Preliminary data that are already at hand suggest that CGM can offer significant improvement to both glycemic control and outcomes of hospitalization.

For more information on CGM, see Section 7, “Diabetes Technology” (<https://doi.org/10.2337/dc22-5007>).

## GLUCOSE-LOWERING TREATMENT IN HOSPITALIZED PATIENTS

### Recommendations

- 16.6** Basal insulin or a basal plus bolus correction insulin regimen is the preferred treatment for non-critically ill hospitalized patients with poor oral intake or those who are taking nothing by mouth. **A**
- 16.7** An insulin regimen with basal, prandial, and correction components is the preferred treatment for non-critically ill hospitalized patients with good nutritional intake. **A**
- 16.8** Use of only a sliding scale insulin regimen in the inpatient hospital setting is strongly discouraged. **A**

### 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 (3).

#### Noncritical Care Setting

In most instances, insulin is the preferred treatment for hyperglycemia in hospitalized patients. However, in certain circumstances, it may be appropriate to continue home regimens, including oral

glucose-lowering medications (50). 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 (51–53). 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 (54).

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 (55). 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. 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 (55).

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 preemptively) in general surgery patients with type 2 diabetes (56). Prolonged use of sliding scale insulin regimens as the sole treatment of hyperglycemic inpatients is strongly discouraged (19,57).

While there is evidence for using premixed insulin formulations in the outpatient setting (58), 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 (59). 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 (60,61). 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. Most importantly, patients with type 1 diabetes should always be treated with insulin.

#### **Transitioning Intravenous to Subcutaneous Insulin**

When discontinuing intravenous insulin, a transition protocol is associated with less morbidity and lower costs of care (62,63) and is therefore recommended. A patient with type 1 or type 2 diabetes being transitioned to a subcutaneous regimen should receive a dose of subcutaneous basal insulin 2 h before the intravenous infusion is discontinued. The dose of basal insulin is best calculated on the basis of the insulin infusion rate during the last 6 h when stable glycemic goals were achieved (64). 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 (64,65).

#### **Noninsulin Therapies**

The safety and efficacy of noninsulin glucose-lowering therapies in the hospital setting is an area of active research (66,67). Several recent randomized trials have demonstrated the potential effectiveness of glucagon-like peptide 1 (GLP-1) receptor agonists and dipeptidyl peptidase 4 inhibitors in specific groups of hospitalized

patients (68–71). However, an FDA bulletin states that providers should consider discontinuing saxagliptin and alogliptin in people who develop heart failure (72).

Sodium–glucose cotransporter 2 (SGLT2) inhibitors should be avoided in cases of severe illness, in patients with ketonemia or ketonuria, and during prolonged fasting and surgical procedures (4). Until safety and effectiveness are established, SGLT2 inhibitors are not recommended for routine in-hospital use. Furthermore, the FDA has recently warned that SGLT2 inhibitors should be stopped 3 days before scheduled surgeries (4 days in the case of ertugliflozin).

## **HYPOGLYCEMIA**

### **Recommendations**

- 16.9** 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 for quality improvement/quality assessment. **E**
- 16.10** For individual patients, treatment regimens 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 (73), 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 hypogly-



emia 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 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, as such readings often predict subsequent level 3 hypoglycemia (2). Episodes of hypoglycemia in the hospital should be documented in the medical record and tracked (3).

### 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 (73–75). 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 (76), 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% (77,78). 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, delayed or missed blood glucose checks, 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 (79,80). 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 (81). 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 (82).

Recently, several groups have developed algorithms to predict episodes of hypoglycemia among inpatients (83,84). 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 the creation of a discharge plan. The American Diabetes Association 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 (85).

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.

Many hospitals offer “meals on demand,” allowing patients to order meals from the menu at any time of the day. This option improves patient satisfaction but complicates meal–insulin coordination. Finally, if carbohydrate counting is provided by the hospital kitchen, this option should be used in patients counting carbohydrates at home (86).

### SELF-MANAGEMENT IN THE HOSPITAL

Diabetes self-management in the hospital may be appropriate for specific patients (87,88). 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 (89,90). As outlined in Recommendation 7.29, patients using diabetes devices should be allowed to use them in an inpatient setting when proper supervision is available.

### 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 (91,92). It is particularly important that patients with type 1 diabetes continue to receive basal insulin even if feedings are discontinued.

Most patients receiving basal insulin should continue with their basal dose,

while the dose of insulin for the total daily nutritional component may be calculated as 1 unit of insulin for every 10–15 g carbohydrate in the formula. Commercially available cans of enteral nutrition contain variable amounts of carbohydrate and may be infused at different rates. All of this must be taken into consideration while calculating insulin doses to cover the nutritional component of enteral nutrition (86). Most specialists recommend using NPH insulin twice or three times daily (every 8 or 12 h) to cover patient needs. Adjustments in insulin doses must be made frequently. Correctional insulin should also be administered subcutaneously every 6 h using human regular insulin or every 4 h using a rapid-acting insulin. If enteral nutrition is interrupted, a 10% dextrose infusion must be started immediately to prevent hypoglycemia and to allow time to select more appropriate insulin doses.

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.

In patients receiving nocturnal tube feeding, NPH insulin administered with the initiation of feeding represents a reasonable approach to cover this nutritional load.

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 (93) and should be adjusted daily in the solution. Adding insulin to the parenteral nutrition bag is the safest way to prevent hypoglycemia if the parenteral nutrition is stopped or interrupted. Correctional insulin should be administered subcutaneously. For full enteral/parenteral feeding guidance, please refer to review articles detailing this topic (91,94).

Because continuous enteral or parenteral nutrition results in a continuous postprandial state, any attempt to bring blood glucose levels to below 140 mg/dL (7.8 mmol/L) substantially increases

the risk of hypoglycemia in these patients.

### 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 (95). Glucocorticoid type and duration of action must be considered in determining insulin treatment regimens. Daily-ingested short-acting glucocorticoids such as prednisone reach peak plasma levels in 4–6 h (96) 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 (95). In subjects on once- or twice-daily steroids, administration of intermediate-acting (NPH) insulin is a standard approach. NPH is usually administered in addition to daily basal-bolus insulin or in addition to oral antidiabetes medications. Because NPH action peaks at 4–6 h after administration, it is best to give it concomitantly with steroids (97). For long-acting glucocorticoids such as dexamethasone and multidose or continuous glucocorticoid use, long-acting insulin may be required to control fasting blood glucose (50,98). For higher doses of glucocorticoids, increasing doses of prandial and correctional insulin, sometimes in extraordinary amounts, are often needed in addition to basal insulin (99,100). 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 (101–103) 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. SGLT2 inhibitors must be discontinued 3–4 days before surgery.
5. Withhold any other oral glucose-lowering agents the morning of surgery or procedure and give half of NPH dose or 75–80% doses of long-acting analog or pump basal insulin.
6. Monitor blood glucose at least every 2–4 h while the patient is taking nothing by mouth and dose with short- or rapid-acting insulin as needed.
7. There are no data on the use and/or influence of GLP-1 receptor agonists or ultra-long-acting insulin analogs upon glycemia in perioperative care.

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 (102); 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 a lower risk for hypoglycemia (104).

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) (56,105).

### 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 (106–109).

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 (108). 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 (110). Patients with uncomplicated DKA may sometimes be treated with subcutaneous insulin in the emergency department or step-down units (111), an approach that may be safer and more cost-effective than treatment with intravenous insulin. If subcutaneous insulin administration is used, it is important to provide an 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. For further information regarding treatment, refer to recent in-depth reviews (4).

## TRANSITION FROM THE HOSPITAL TO THE AMBULATORY SETTING

### Recommendation

**16.11** 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 the length of hospital stay and readmission rates and increase patient satisfaction (112). Discharge planning should begin at admission and be updated as patient needs change.

The 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 13, "Older Adults" (<https://doi.org/10.2337/dc22-S013>), for more information.

An outpatient follow-up visit with the primary care provider, endocrinologist, or diabetes care and education specialist within 1 month of discharge is advised for all patients experiencing hyperglycemia in the hospital. If glycemic medications are changed, or if 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 (7). 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 recommends that, at a minimum, discharge plans include the following (113):

### 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 the 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 (114,115). 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 (116). 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 (114,115). While there is no standard to prevent readmissions, several successful strategies have been reported (115). These include targeting ketosis-prone patients with type 1 diabetes (117), insulin treatment of patients with admission A1C >9% (75 mmol/mol) (118), and use of a transitional care model (119). For people with diabetic kidney disease, collaborative patient-centered medical homes may decrease risk-adjusted readmission rates (120). A recently published algorithm based on patient demographic and clinical characteristics had only moderate predictive power but identifies a promising future strategy (121).

Age is also an important risk factor in hospitalization and readmission among patients with diabetes (refer to Section 13, "Older Adults," <https://doi.org/10.2337/dc22-S013>, for detailed criteria).

## References

- Clement S, Braithwaite SS, Magee MF, et al.; American Diabetes Association Diabetes in Hospitals Writing Committee. Management of diabetes and hyperglycemia in hospitals [published corrections appear in *Diabetes Care* 2004;27:856 and *Diabetes Care* 2004;27:1255]. *Diabetes Care* 2004;27:553–591
- Moghissi ES, Korytkowski MT, DiNardo M, et al.; American Association of Clinical Endocrinologists; American Diabetes Association. American Association of Clinical Endocrinologists and American Diabetes Association consensus statement on inpatient glycemic control. *Diabetes Care* 2009;32:1119–1131
- Bogun M, Inzucchi SE. Inpatient management of diabetes and hyperglycemia. *Clin Ther* 2013;35:724–733
- Moghissi E, Inzucchi S. The evolution of glycemic control in the hospital setting. In *Managing Diabetes and Hyperglycemia in the Hospital Setting*. Draznin B, Ed. Alexandria, VA, American Diabetes Association, 2016, pp. 1–10
- Umpierrez G, Korytkowski M. Diabetic emergencies - ketoacidosis, hyperglycaemic hyperosmolar state and hypoglycaemia. *Nat Rev Endocrinol* 2016;12:222–232
- Pasquel FJ, Gomez-Huelgas R, Anzola I, et al. Predictive value of admission hemoglobin A<sub>1c</sub> on inpatient glycemic control and response to insulin therapy in medicine and surgery patients with type 2 diabetes. *Diabetes Care* 2015;38:e202–e203
- Umpierrez GE, Reyes D, Smiley D, et al. Hospital discharge algorithm based on admission HbA<sub>1c</sub> for the management of patients with type 2 diabetes. *Diabetes Care* 2014;37:2934–2939
- Carpenter DL, Gregg SR, Xu K, Buchman TG, Coopersmith CM. Prevalence and impact of unknown diabetes in the ICU. *Crit Care Med* 2015;43:e541–e550
- Rhee MK, Safo SE, Jackson SL, et al. Inpatient glucose values: determining the nondiabetic range and use in identifying patients at high risk for diabetes. *Am J Med* 2018;131:443.e11–443.e24
- Garg R, Schuman B, Bader A, et al. Effect of preoperative diabetes management on glycemic control and clinical outcomes after elective surgery. *Ann Surg* 2018;267:858–862
- van den Boom W, Schroeder RA, Manning MW, Setji TL, Fiestan G-O, Dunson DB. Effect of A1C and glucose on postoperative mortality in noncardiac and cardiac surgeries. *Diabetes Care* 2018;41:782–788
- Setji T, Hopkins TJ, Jimenez M, et al. Rationalization, development, and implementation of a preoperative diabetes optimization program designed to improve perioperative outcomes and reduce cost. *Diabetes Spectr* 2017;30:217–223
- Okabayashi T, Shima Y, Sumiyoshi T, et al. Intensive versus intermediate glucose control in surgical intensive care unit patients. *Diabetes Care* 2014;37:1516–1524
- Institute of Medicine. *Preventing Medication Errors*. Aspden P, Wolcott J, Bootman JL, Cronenwett LR, Eds. Washington, DC, National Academies Press, 2007
- Gillaizeau F, Chan E, Trinquart L, et al. Computerized advice on drug dosage to improve prescribing practice. *Cochrane Database Syst Rev* 2013;11:CD002894
- Wexler DJ, Shrader P, Burns SM, Cagliero E. Effectiveness of a computerized insulin order template in general medical inpatients with type 2 diabetes: a cluster randomized trial. *Diabetes Care* 2010;33:2181–2183
- Schnipper JL, Liang CL, Ndumele CD, Pendergrass ML. Effects of a computerized order set on the inpatient management of hyperglycemia: a cluster-randomized controlled trial. *Endocr Pract* 2010;16:209–218
- Wang YJ, Seggelke S, Hawkins RM, et al. Impact of glucose management team on outcomes of hospitalization in patients with type 2 diabetes admitted to the medical service. *Endocr Pract* 2016;22:1401–1405
- Draznin B, Gilden J, Golden SH, et al.; PRIDE investigators. Pathways to quality inpatient management of hyperglycemia and diabetes: a call to action. *Diabetes Care* 2013;36:1807–1814
- Bansal V, Mottalib A, Pawar TK, et al. Inpatient diabetes management by specialized diabetes team versus primary service team in non-critical care units: impact on 30-day readmission rate and hospital cost. *BMJ Open Diabetes Res Care* 2018;6:e000460
- Ostling S, Wyckoff J, Ciarkowski SL, et al. The relationship between diabetes mellitus and 30-day readmission rates. *Clin Diabetes Endocrinol* 2017;3:3
- Rushakoff RJ, Sullivan MM, MacMaster HW, et al. Association between a virtual glucose management service and glycemic control in hospitalized adult patients: an observational study. *Ann Intern Med* 2017;166:621–627
- Arnold P, Scheurer D, Dake AW, et al. Hospital guidelines for diabetes management and the Joint Commission-American Diabetes Association inpatient diabetes certification. *Am J Med Sci* 2016;351:333–341
- Society of Hospital Medicine. Glycemic control for hospitalists. Accessed 17 October 2021. Available from <https://www.hospitalmedicine.org/clinical-topics/glycemic-control/>
- Umpierrez GE, Hellman R, Korytkowski MT, et al.; Endocrine Society. Management of hyperglycemia in hospitalized patients in non-critical care setting: an endocrine society clinical practice guideline. *J Clin Endocrinol Metab* 2012;97:16–38
- Agiostatidou G, Anhalt H, Ball D, et al. Standardizing clinically meaningful outcome measures beyond HbA<sub>1c</sub> for type 1 diabetes: a consensus report of the American Association of Clinical Endocrinologists, the American Association of Diabetes Educators, the American Diabetes Association, the Endocrine Society, JDRF International, The Leona M. and Harry B. Helmsley Charitable Trust, the Pediatric Endocrine Society, and the T1D Exchange. *Diabetes Care* 2017;40:1622–1630
- van den Berghe G, Wouters P, Weekers F, et al. Intensive insulin therapy in critically ill patients. *N Engl J Med* 2001;345:1359–1367
- Finfer S, Chittock DR, Su SY, et al.; NICE-SUGAR Study Investigators. Intensive versus conventional glucose control in critically ill patients. *N Engl J Med* 2009;360:1283–1297
- Kansagara D, Fu R, Freeman M, Wolf F, Helfand M. Intensive insulin therapy in hospitalized patients: a systematic review. *Ann Intern Med* 2011;154:268–282
- Sathya B, Davis R, Taveira T, Whitlatch H, Wu W-C. Intensity of peri-operative glycemic control and postoperative outcomes in patients with diabetes: a meta-analysis. *Diabetes Res Clin Pract* 2013;102:8–15
- Umpierrez G, Cardona S, Pasquel F, et al. Randomized controlled trial of intensive versus conservative glucose control in patients undergoing coronary artery bypass graft surgery: GLUCO-CABG Trial. *Diabetes Care* 2015;38:1665–1672
- Duncan AE, Abd-Elsayed A, Maheshwari A, Xu M, Soltesz E, Koch CG. Role of intraoperative and postoperative blood glucose concentrations in predicting outcomes after cardiac surgery. *Anesthesiology* 2010;112:860–871
- Furnary AP, Wu Y, Bookin SO. Effect of hyperglycemia and continuous intravenous insulin infusions on outcomes of cardiac surgical procedures: the Portland Diabetic Project. *Endocr Pract* 2004;10(Suppl. 2):21–33
- Low Wang CC, Draznin B. Practical approach to management of inpatient hyperglycemia in select patient populations. *Hosp Pract (1995)* 2013;41:45–53
- Cobaugh DJ, Maynard G, Cooper L, et al. Enhancing insulin-use safety in hospitals: practical recommendations from an ASHP Foundation expert consensus panel. *Am J Health Syst Pharm* 2013;70:1404–1413
- Rice MJ, Coursin DB. Glucose meters: here today, gone tomorrow? *Crit Care Med* 2016;44:e97–e100



37. Rice MJ, Smith JL, Coursin DB. Glucose measurement in the ICU: regulatory intersects reality. *Crit Care Med* 2017;45:741–743
38. Klonoff DC, Draznin B, Drincic A, et al. PRIDE statement on the need for a moratorium on the CMS plan to cite hospitals for performing point-of-care capillary blood glucose monitoring on critically ill patients. *J Clin Endocrinol Metab* 2015;100:3607–3612
39. DuBois JA, Slingerland RJ, Fokkert M, et al. Bedside glucose monitoring—is it safe? A new, regulatory-compliant risk assessment evaluation protocol in critically ill patient care settings. *Crit Care Med* 2017;45:567–574
40. Zhang R, Isakow W, Kollef MH, Scott MG. Performance of a modern glucose meter in ICU and general hospital inpatients: 3 years of real-world paired meter and central laboratory results. *Crit Care Med* 2017;45:1509–1514
41. Wallia A, Prince G, Touma E, El Muayed M, Seley JJ. Caring for hospitalized patients with diabetes mellitus, hyperglycemia, and COVID-19: bridging the remaining knowledge gaps. *Curr Diab Rep* 2020;20:77
42. Aljehani FA, Funke K, Hermayer KL. Inpatient diabetes and hyperglycemia management protocol in the COVID-19 era. *Am J Med Sci* 2020;360:423–426
43. Pasquel FJ, Umpierrez GE. Individualizing inpatient diabetes management during the coronavirus disease 2019 pandemic. *J Diabetes Sci Technol* 2020;14:705–707
44. Ceriello A, Standl E, Catrinou D, et al.; “Diabetes and Cardiovascular Disease (D&CVD)” Study Group of the European Association for the Study of Diabetes (EASD). Issues for the management of people with diabetes and COVID-19 in ICU. *Cardiovasc Diabetol* 2020;19:114
45. Korytkowski M, Antinori-Lent K, Drincic A, et al. A pragmatic approach to inpatient diabetes management during the COVID-19 pandemic. *J Clin Endocrinol Metab* 2020;105:dga342
46. Sadhu AR, Serrano IA, Xu J, et al. Continuous glucose monitoring in critically ill patients with COVID-19: results of an emergent pilot study. *J Diabetes Sci Technol* 2020;14:1065–1073
47. Galindo RJ, Aleppo G, Klonoff DC, et al. Implementation of continuous glucose monitoring in the hospital: emergent considerations for remote glucose monitoring during the COVID-19 pandemic. *J Diabetes Sci Technol* 2020;14:822–832
48. Agarwal S, Mathew J, Davis GM, et al. Continuous glucose monitoring in the intensive care unit during the COVID-19 pandemic. *Diabetes Care* 2021;44:847–849
49. Faulds ER, Jones L, McNett M, et al. Facilitators and barriers to nursing implementation of continuous glucose monitoring (CGM) in critically ill patients with COVID-19. *Endocr Pract* 2021;27:354–361
50. Maynard G, Wesorick DH, O’Malley C; Society of Hospital Medicine Glycemic Control Task Force. Subcutaneous insulin order sets and protocols: effective design and implementation strategies. *J Hosp Med* 2008;3(Suppl.):29–41
51. Brown KE, Hertig JB. Determining current insulin pen use practices and errors in the inpatient setting. *Jt Comm J Qual Patient Saf* 2016;42:568–575, AP1–AP7
52. Horne J, Bond R, Sarangarm P. Comparison of inpatient glycemic control with insulin vials versus insulin pens in general medicine patients. *Hosp Pharm* 2015;50:514–521
53. Veronesi G, Poerio CS, Braus A, et al. Determinants of nurse satisfaction using insulin pen devices with safety needles: an exploratory factor analysis. *Clin Diabetes Endocrinol* 2015;1:15
54. U.S. Food and Drug Administration. FDA Drug Safety Communication: FDA requires label warnings to prohibit sharing of multi-dose diabetes pen devices among patients. Accessed 17 October 2021. Available from <https://www.fda.gov/Drugs/DrugSafety/ucm435271.htm>
55. Bueno E, Benitez A, Rufinelli JV, et al. Basal-bolus regimen with insulin analogues versus human insulin in medical patients with type 2 diabetes: a randomized controlled trial in Latin America. *Endocr Pract* 2015;21:807–813
56. Umpierrez GE, Smiley D, Jacobs S, et al. Randomized study of basal-bolus insulin therapy in the inpatient management of patients with type 2 diabetes undergoing general surgery (RABBIT 2 surgery). *Diabetes Care* 2011;34:256–261
57. Colunga-Lozano LE, Gonzalez Torres FJ, Delgado-Figueroa N, et al. Sliding scale insulin for non-critically ill hospitalized adults with diabetes mellitus. *Cochrane Database Syst Rev* 2018;11:CD011296
58. Giugliano D, Chiodini P, Maiorino MI, Bellastella G, Esposito K. Intensification of insulin therapy with basal-bolus or premixed insulin regimens in type 2 diabetes: a systematic review and meta-analysis of randomized controlled trials. *Endocrine* 2016;51:417–428
59. Bellido V, Suarez L, Rodriguez MG, et al. Comparison of basal-bolus and premixed insulin regimens in hospitalized patients with type 2 diabetes. *Diabetes Care* 2015;38:2211–2216
60. Baldwin D, Zander J, Munoz C, et al. A randomized trial of two weight-based doses of insulin glargine and glulisine in hospitalized subjects with type 2 diabetes and renal insufficiency. *Diabetes Care* 2012;35:1970–1974
61. Iyengar R, Franzese J, Gianchandani R. Inpatient glycemic management in the setting of renal insufficiency/failure/dialysis. *Curr Diab Rep* 2018;18:75
62. Shomali ME, Herr DL, Hill PC, Pehlivanova M, Sharretts JM, Magee MF. Conversion from intravenous insulin to subcutaneous insulin after cardiovascular surgery: transition to target study. *Diabetes Technol Ther* 2011;13:121–126
63. Lien LF, Low Wang CC, Kreider KE, Baldwin D. Transitioning from intravenous to subcutaneous insulin. In *Managing Diabetes and Hyperglycemia in the Hospital Setting*. Draznin B, Ed. Alexandria, VA, American Diabetes Association, 2016, pp. 115–128
64. Tripathy PR, Lansang MC. U-500 regular insulin use in hospitalized patients. *Endocr Pract* 2015;21:54–58
65. Lansang MC, Umpierrez GE. Inpatient hyperglycemia management: a practical review for primary medical and surgical teams. *Cleve Clin J Med* 2016;83(Suppl. 1):S34–S43
66. Umpierrez GE, Gianchandani R, Smiley D, et al. Safety and efficacy of sitagliptin therapy for the inpatient management of general medicine and surgery patients with type 2 diabetes: a pilot, randomized, controlled study. *Diabetes Care* 2013;36:3430–3435
67. Pasquel FJ, Fayman M, Umpierrez GE. Debate on insulin vs non-insulin use in the hospital setting—is it time to revise the guidelines for the management of inpatient diabetes? *Curr Diab Rep* 2019;19:65
68. Fushimi N, Shibuya T, Yoshida Y, Ito S, Hachiya H, Mori A. Dulaglutide-combined basal plus correction insulin therapy contributes to ideal glycemic control in non-critical hospitalized patients. *J Diabetes Investig* 2020;11:125–131
69. Fayman M, Galindo RJ, Rubin DJ, et al. A randomized controlled trial on the safety and efficacy of exenatide therapy for the inpatient management of general medicine and surgery patients with type 2 diabetes. *Diabetes Care* 2019;42:450–456
70. Pérez-Belmonte LM, Osuna-Sánchez J, Millán-Gómez M, et al. Glycaemic efficacy and safety of linagliptin for the management of non-cardiac surgery patients with type 2 diabetes in a real-world setting: Lina-Surg study. *Ann Med* 2019;51:252–261
71. Vellanki P, Rasouli N, Baldwin D, et al. Glycaemic efficacy and safety of linagliptin compared to basal-bolus insulin regimen in patients with type 2 diabetes undergoing non-cardiac surgery: a multicenter randomized clinical trial. *Diabetes Obes Metab* 2019;21:837–843
72. U.S. Food and Drug Administration. FDA Drug Safety Communication: FDA adds warnings about heart failure risk to labels of type 2 diabetes medicines containing saxagliptin and alogliptin. Accessed 17 October 2021. Available from <https://www.fda.gov/Drugs/DrugSafety/ucm486096.htm>
73. Akirov A, Grossman A, Shochat T, Shimon I. Mortality among hospitalized patients with hypoglycemia: insulin related and noninsulin related. *J Clin Endocrinol Metab* 2017;102:416–424
74. Amori RE, Pittas AG, Siegel RD, et al. Inpatient medical errors involving glucose-lowering medications and their impact on patients: review of 2,598 incidents from a voluntary electronic error-reporting database. *Endocr Pract* 2008;14:535–542
75. Alwan D, Chipps E, Yen P-Y, Dungan K. Evaluation of the timing and coordination of prandial insulin administration in the hospital. *Diabetes Res Clin Pract* 2017;131:18–32
76. Hung AM, Siew ED, Wilson OD, et al. Risk of hypoglycemia following hospital discharge in patients with diabetes and acute kidney injury. *Diabetes Care* 2018;41:503–512
77. Maynard G, Kulasa K, Ramos P, et al. Impact of a hypoglycemia reduction bundle and a systems approach to inpatient glycemic management. *Endocr Pract* 2015;21:355–367
78. Milligan PE, Cox MC, Pratt E, Hoehner CM, Krettek JE, Dunagan WC. Multifaceted approach to reducing occurrence of severe hypoglycemia in a large healthcare system. *Am J Health Syst Pharm* 2015;72:1631–1641
79. Dagogo-Jack S. Hypoglycemia in type 1 diabetes mellitus: pathophysiology and prevention. *Treat Endocrinol* 2004;3:91–103
80. Rickels MR. Hypoglycemia-associated autonomic failure, counterregulatory responses, and therapeutic options in type 1 diabetes. *Ann N Y Acad Sci* 2019;1454:68–79
81. Dendy JA, Chockalingam V, Tirumalasetty NN, et al. Identifying risk factors for severe

- hypoglycemia in hospitalized patients with diabetes. *Endocr Pract* 2014;20:1051–1056
82. Ulmer BJ, Kara A, Mariash CN. Temporal occurrences and recurrence patterns of hypoglycemia during hospitalization. *Endocr Pract* 2015;21:501–507
83. Shah BR, Walji S, Kiss A, James JE, Lowe JM. Derivation and validation of a risk-prediction tool for hypoglycemia in hospitalized adults with diabetes: the Hypoglycemia During Hospitalization (HyDHo) score. *Can J Diabetes* 2019;43:278–282.e1
84. Mathioudakis NN, Everett E, Routh S, et al. Development and validation of a prediction model for insulin-associated hypoglycemia in non-critically ill hospitalized adults. *BMJ Open Diabetes Res Care* 2018;6:e000499
85. Curll M, Dinardo M, Noschese M, Korytkowski MT. Menu selection, glycaemic control and satisfaction with standard and patient-controlled consistent carbohydrate meal plans in hospitalised patients with diabetes. *Qual Saf Health Care* 2010;19:355–359
86. Korytkowski M, Draznin B, Drincic A. Food, fasting, insulin, and glycemic control in the hospital. In *Managing Diabetes and Hyperglycemia in the Hospital Setting*. Draznin B, Ed. Alexandria, VA, American Diabetes Association, 2016, pp. 70–83
87. Mabrey ME, Setji TL. Patient self-management of diabetes care in the inpatient setting. *pro. J Diabetes Sci Technol* 2015;9:1152–1154
88. Shah AD, Rushakoff RJ. Patient self-management of diabetes care in the inpatient setting. *con. J Diabetes Sci Technol* 2015;9:1155–1157
89. Umpierrez GE, Klonoff DC. Diabetes technology update: use of insulin pumps and continuous glucose monitoring in the hospital. *Diabetes Care* 2018;41:1579–1589
90. Houlden RL, Moore S. In-hospital management of adults using insulin pump therapy. *Can J Diabetes* 2014;38:126–133
91. Korytkowski MT, Salata RJ, Koerbel GL, et al. Insulin therapy and glycemic control in hospitalized patients with diabetes during enteral nutrition therapy: a randomized controlled clinical trial. *Diabetes Care* 2009;32:594–596
92. Hsia E, Seggelke SA, Gibbs J, Rasouli N, Draznin B. Comparison of 70/30 biphasic insulin with glargine/lispro regimen in non-critically ill diabetic patients on continuous enteral nutrition therapy. *Nutr Clin Pract* 2011;26:714–717
93. Drincic AT, Knezevich JT, Akkireddy P. Nutrition and hyperglycemia management in the inpatient setting (meals on demand, parenteral, or enteral nutrition). *Curr Diab Rep* 2017;17:59
94. Low Wang CC, Hawkins RM, Gianchandani R, Dungan K. Glycemic control in the setting of parenteral or enteral nutrition via tube feeding. In *Managing Diabetes and Hyperglycemia in the Hospital Setting*. Draznin B, Ed. Alexandria, VA, American Diabetes Association, 2016, pp. 84–98
95. Pichardo-Lowden AR, Fan CY, Gabbay RA. Management of hyperglycemia in the non-intensive care patient: featuring subcutaneous insulin protocols. *Endocr Pract* 2011;17:249–260
96. Roberts A, James J; Joint British Diabetes Societies (JBDS) for Inpatient Care. Management of hyperglycaemia and steroid (glucocorticoid) therapy: a guideline from the Joint British Diabetes Societies (JBDS) for Inpatient Care group. *Diabet Med* 2018;35:1011–1017
97. Kwon S, Hermayer KL, Hermayer K. Glucocorticoid-induced hyperglycemia. *Am J Med Sci* 2013;345:274–277
98. Seggelke SA, Gibbs J, Draznin B. Pilot study of using neutral protamine Hagedorn insulin to counteract the effect of methylprednisolone in hospitalized patients with diabetes. *J Hosp Med* 2011;6:175–176
99. Mathioudakis N, Dungan K, Baldwin D, Korytkowski M, Reider J. Steroid-associated hyperglycemia. In *Managing Diabetes and Hyperglycemia in the Hospital Setting*. Draznin B, Ed. Alexandria, VA, American Diabetes Association, 2016, pp. 99–114
100. Brady V, Thosani S, Zhou S, Bassett R, Busaidy NL, Lavis V. Safe and effective dosing of basal-bolus insulin in patients receiving high-dose steroids for hyper-cyclophosphamide, doxorubicin, vincristine, and dexamethasone chemotherapy. *Diabetes Technol Ther* 2014;16:874–879
101. Smiley DD, Umpierrez GE. Perioperative glucose control in the diabetic or nondiabetic patient. *South Med J* 2006;99:580–589; quiz 590–591
102. Buchleitner AM, Martínez-Alonso M, Hernández M, Solà I, Mauricio D. Perioperative glycaemic control for diabetic patients undergoing surgery. *Cochrane Database Syst Rev* 2012;9:CD007315
103. Gianchandani R, Dubois E, Alexanian S, Rushakoff R. Preoperative, intraoperative, and postoperative glucose management. In *Managing Diabetes and Hyperglycemia in the Hospital Setting*. Draznin B, Ed. Alexandria, VA, American Diabetes Association, 2016, pp. 129–144
104. Demma LJ, Carlson KT, Duggan EW, Morrow JG 3rd, Umpierrez G. Effect of basal insulin dosage on blood glucose concentration in ambulatory surgery patients with type 2 diabetes. *J Clin Anesth* 2017;36:184–188
105. Umpierrez GE, Smiley D, Hermayer K, et al. Randomized study comparing a basal-bolus with a basal plus correction insulin regimen for the hospital management of medical and surgical patients with type 2 diabetes: basal plus trial. *Diabetes Care* 2013;36:2169–2174
106. Kitabchi AE, Umpierrez GE, Miles JM, Fisher JN. Hyperglycemic crises in adult patients with diabetes. *Diabetes Care* 2009;32:1335–1343
107. Vellanki P, Umpierrez GE. Diabetic ketoacidosis: a common debut of diabetes among African Americans with type 2 diabetes. *Endocr Pract* 2017;23:971–978
108. Harrison VS, Rustico S, Palladino AA, Ferrara C, Hawkes CP. Glargine co-administration with intravenous insulin in pediatric diabetic ketoacidosis is safe and facilitates transition to a subcutaneous regimen. *Pediatr Diabetes* 2017;18:742–748
109. Hsia E, Seggelke S, Gibbs J, et al. Subcutaneous administration of glargine to diabetic patients receiving insulin infusion prevents rebound hyperglycemia. *J Clin Endocrinol Metab* 2012;97:3132–3137
110. Andrade-Castellanos CA, Colunga-Lozano LE, Delgado-Figueroa N, Gonzalez-Padilla DA. Subcutaneous rapid-acting insulin analogues for diabetic ketoacidosis. *Cochrane Database Syst Rev* 2016;1:CD011281
111. Kitabchi AE, Umpierrez GE, Fisher JN, Murphy MB, Stentz FB. Thirty years of personal experience in hyperglycemic crises: diabetic ketoacidosis and hyperglycemic hyperosmolar state. *J Clin Endocrinol Metab* 2008;93:1541–1552
112. Shepperd S, Lannin NA, Clemson LM, McCluskey A, Cameron ID, Barras SL. Discharge planning from hospital to home. *Cochrane Database Syst Rev* 1996;1:CD000313
113. Agency for Healthcare Research and Quality. Patient Safety Network – Readmissions and adverse events after discharge, 2019. Accessed 17 October 2021. Available from <https://psnet.ahrq.gov/primer/readmissions-and-adverse-events-after-discharge>
114. Rubin DJ. Hospital readmission of patients with diabetes. *Curr Diab Rep* 2015;15:17
115. Gregory NS, Seley JJ, Dargar SK, Galla N, Gerber LM, Lee JI. Strategies to prevent readmission in high-risk patients with diabetes: the importance of an interdisciplinary approach. *Curr Diab Rep* 2018;18:54
116. Jiang HJ, Stryer D, Friedman B, Andrews R. Multiple hospitalizations for patients with diabetes. *Diabetes Care* 2003;26:1421–1426
117. Maldonado MR, D’Amico S, Rodriguez L, Iyer D, Balasubramanyam A. Improved outcomes in indigent patients with ketosis-prone diabetes: effect of a dedicated diabetes treatment unit. *Endocr Pract* 2003;9:26–32
118. Wu EQ, Zhou S, Yu A, Lu M, Sharma H, Gill J, et al. Outcomes associated with post-discharge insulin continuity in US patients with type 2 diabetes mellitus initiating insulin in the hospital. *Hosp Pract (1995)* 2012;40:40–48
119. Hirschman KB, Bixby MB. Transitions in care from the hospital to home for patients with diabetes. *Diabetes Spectr* 2014;27:192–195
120. Tuttle KR, Bakris GL, Bilous RW, et al. Diabetic kidney disease: a report from an ADA Consensus Conference. *Diabetes Care* 2014;37:2864–2883
121. Rubin DJ, Recco D, Turchin A, Zhao H, Golden SH. External validation of the Diabetes Early Readmission Risk Indicator (Derrim™). *Endocr Pract* 2018;24:527–541