16. Diabetes Care in the Hospital: Standards of Care in Diabetes—2026

*American Diabetes Association Professional Practice Committee for Diabetes**

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The American Diabetes Association (ADA) "Standards of 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 for Diabetes, an interprofessional expert committee, 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 and a full list of Professional Practice Committee members, please refer to Introduction and Methodology. Readers who wish to comment on the Standards of Care are invited to do so at professional.diabetes.org/SOC.

Among hospitalized individuals, hyperglycemia, hypoglycemia, and glucose variability are associated with adverse outcomes, including increased morbidity and mortality (1,2). Identification and careful management of people with diabetes and dysglycemia during hospitalization has direct and immediate benefits. Diabetes management in the inpatient setting includes identification and treatment of hyperglycemia and hypoglycemia, diagnosing and managing hyperglycemic crises, perioperative care planning, and a proactive transition plan for outpatient diabetes care with timely scheduled follow-up appointments. These steps can improve outcomes, shorten hospital stays, and reduce the need for readmission and emergency department visits. For older individuals or for people with diabetes in post-acute and long-term care settings, please see section 13, "Older Adults."

HOSPITAL CARE DELIVERY STANDARDS

Recommendations

16.1 Perform an A1C test on all people with diabetes or hyperglycemia (random blood glucose >140 mg/dL [>7.8 mmol/L]) at the time of admission to the hospital if no A1C test result is available from the prior 3 months. **B**

16.2 Institutions should implement protocols using validated written or computerized provider order entry sets for management of dysglycemia in the hospital that allow for a personalized approach. **B**

Considerations on Admission

Initial evaluation should state the type of diabetes (i.e., type 1, type 2, gestational, pancreatogenic, stress hyperglycemia, drug related, or nutrition related [e.g., enteral or parenteral nutrition]) when it is known. To identify people with undiagnosed diabetes, and

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because inpatient treatment and discharge planning are more effective when preadmission glycemia is considered, A1C should be measured for all people with diabetes or dysglycemia at the time of admission to the hospital or soon after if no A1C test result is available from the previous 3 months (3–5). Incorporating A1C into the glucose management order set may help increase frequency of A1C testing (6). In addition, diabetes self-management knowledge and behaviors should be assessed on admission, and diabetes self-management education should be provided throughout the hospital stay, especially if a new treatment plan is being considered. Diabetes self-management education should include the knowledge and skills needed after discharge, such as medication dosing and administration, meal planning, glucose monitoring, and recognition and treatment of hypoglycemia (7). For individuals residing in group homes or institutional settings (8), information on site capabilities related to diabetes management should be obtained and the therapeutic plan should be adjusted accordingly.

High-quality hospital care for diabetes requires clear and actionable standards for care delivery, which are best implemented using structured order sets with computerized provider order entry (CPOE) as well as quality improvement strategies for process improvement (9). The National Academy of Medicine recommends CPOE to prevent medication-related errors and to increase medication administration efficiency (10). Systematic reviews of randomized controlled trials using computerized assistance to improve glycemic outcomes in the hospital found significant improvement in the percentage of time individuals spent in the glycemic goal range, lower mean blood glucose levels, and no increase in hypoglycemia (11). Where feasible, the structured order set should provide computerized guidance for glycemic management, including initial weight-based insulin dosing guidance and insulin titration guidance during the hospital stay (12). Currently available commercial electronic glucose management systems may facilitate implementation of insulin protocols in the hospital (13,14).

Diabetes Care Teams in the Hospital

Recommendation

16.3 When caring for hospitalized people with diabetes (with an existing or new diagnosis) or stress hyperglycemia, consult with a specialized diabetes or glucose management team when available. **B**

Care provided by appropriately trained specialists or specialty teams may reduce the length of stay and improve glycemic and other clinical outcomes (15–17). In addition, the increased 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 diabetes management team (15,18). In a cross-sectional study comparing usual care to care provided by a virtual glucose management service based on the daily chart review and making recommendations through the electronic health record (EHR), rates of both hyperglycemia and hypoglycemia were reduced by 30–40% (19). In addition, providing diabetes self-management education and developing a diabetes discharge plan that includes continued access to diabetes medications and supplies and ongoing education and support are key strategies to improve long-term outcomes (20,21). Hospital diabetes care teams may include and be led by physicians or other health care professionals trained in diabetes care and education such as nurse practitioners or physician assistants/associates, nurses, registered dietitian nutritionists, or pharmacists (22). Details of diabetes care team composition and other resources are available from the Joint Commission accreditation program for the hospital care of diabetes, the Society of Hospital Medicine workbook, The Leapfrog Group, and the Joint British Diabetes Societies (JBDS) for Inpatient Care Group (23–26).

GLYCEMIC GOALS IN HOSPITALIZED ADULTS

Recommendations

16.4a Insulin should be initiated or intensified for treatment of persistent hyperglycemia starting at a threshold of ≥180 mg/dL (≥10.0 mmol/L) (confirmed on two occasions within 24 h) for the majority of critically ill individuals (those in the intensive care unit [ICU]). **A**

16.4b Insulin and/or other glucose lowering therapies should be initiated or intensified for treatment of persistent hyperglycemia starting at a threshold of ≥180 mg/dL (≥10.0 mmol/L) (confirmed on two occasions within 24 h) for the majority of noncritically ill individuals (those not in the ICU). **B**

16.5a Once therapy is initiated, a glycemic goal of 140–180 mg/dL (7.8–10.0 mmol/L) is recommended for most critically ill individuals (those in the ICU) with hyperglycemia. **A** More stringent individualized glycemic goals may be appropriate for selected critically ill individuals if they can be achieved without significant hypoglycemia. **B**

16.5b For noncritically ill individuals (those not in the ICU), a glycemic goal of 100–180 mg/dL (5.6–10.0 mmol/L) is recommended if it can be achieved without significant hypoglycemia. **B**

Standard Definitions of Glucose Abnormalities

Hyperglycemia in hospitalized individuals is defined as any blood glucose level >140 mg/dL (>7.8 mmol/L) based on the threshold for an abnormal glucose level (27). An admission A1C value ≥6.5% (≥48 mmol/mol) suggests that the onset of diabetes preceded hospitalization (see section 2, "Diagnosis and Classification of Diabetes"). Hypoglycemia is defined as blood glucose <70 mg/dL (<3.9 mmol/L) and is further stratified into three categories: level 1 (glucose concentration of 54–69 mg/dL [3.0–3.8 mmol/L]), level 2 (glucose concentration <54 mg/dL [<3.0 mmol/L], which is typically the threshold for neuroglycopenic symptoms), and level 3 (a clinical event characterized by altered mental and/or physical functioning that requires assistance from another person for recovery) (**Table 6.4**). Levels 2 and 3 hypoglycemia require immediate intervention and correction of low blood glucose. Prompt treatment of level 1 hypoglycemia is recommended for prevention of progression to more significant level 2 and level 3 hypoglycemia.

Glycemic Goals

In a landmark clinical trial conducted in a surgical intensive care unit (ICU), Van den Berghe et al. (28) demonstrated that an intensive intravenous insulin protocol with a glycemic goal of 80–110 mg/dL (4.4–6.1 mmol/L) reduced mortality by 40% compared with a standard approach

of a glycemic goal of 180–215 mg/dL (10–12 mmol/L) in critically ill hospitalized individuals with diabetes and/or stress hyperglycemia and recent surgery. However, several multicenter studies, including the Normoglycemia in Intensive Care Evaluation and Survival Using Glucose Algorithm Regulation (NICE-SUGAR) trial, in critically ill hospitalized individuals in medical and surgical ICUs (29–31) failed to replicate these data. In the NICE-SUGAR trial, critically ill individuals randomized to intensive glycemic management (80–110 mg/dL [4.4–6.1 mmol/L]) derived no significant treatment advantage compared with a group with more moderate glycemic goals (140–180 mg/dL [7.8–10.0 mmol/L]) and had slightly but significantly higher mortality (27.5% vs. 25%). The intensively treated group had 10- to 15-fold greater rates of hypoglycemia. The findings from the NICE-SUGAR trial, supported by several meta-analyses showed higher rates of hypoglycemia and an increase in mortality with more aggressive glycemic management goals compared with moderate glycemic goals (29,32,33). More recently, a multicenter randomized controlled trial comparing tight and liberal glucose management in critically ill individuals not receiving early parenteral nutrition showed no benefit of tight glycemic management despite effective glucose separation between the groups and remarkably low rates of hypoglycemia in both groups (1.0% in tight group vs. 0.7% in liberal group) (30). Based on these clinical trials and results of other observational studies, insulin and/or other therapies should be initiated for the treatment of persistent hyperglycemia ≥180 mg/dL (≥10.0 mmol/L). Once therapy is initiated, a glycemic goal of 140–180 mg/dL (7.8–10.0 mmol/L) is recommended for most critically ill individuals. More stringent glycemic goals, such as 110–140 mg/dL (6.1–7.8 mmol/L), may be appropriate for selected individuals (e.g., critically ill individuals undergoing cardiac surgery) if they can be achieved without significant hypoglycemia (34,35). For hospitalized individuals without critical illness, a glycemic goal of 100–180 mg/dL (5.6–10.0 mmol/L) is recommended, whether it is hyperglycemia due to newly diagnosed diabetes or stress hyperglycemia or hyperglycemia related to diabetes prior to admission (36,37). It has been found that fasting glucose levels <100 mg/dL (<5.6 mmol/L) are predictors of hypoglycemia within the next 24 h (38) and therefore necessitate basal insulin dose adjustments. Higher glycemic levels (up to 250 mg/dL [13.9 mmol/L]) may be acceptable in selected populations (terminally ill individuals with short life expectancy, advanced kidney failure [and/or on dialysis], high risk for hypoglycemia, and/or labile glycemic excursions). In these individuals, less aggressive treatment goals that would help avoid symptomatic hypoglycemia and/or hyperglycemia are often 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 treatment goals.

GLUCOSE MONITORING

In hospitalized individuals with diabetes who are eating, point-of-care (POC) blood glucose monitoring should be performed before meals; in those not eating, glucose monitoring is advised every 4–6 h (36). More frequent POC blood glucose monitoring typically ranging from every 30 min to every 2 h is recommended for safe use of intravenous insulin therapy.

Hospital blood glucose monitoring should be performed with U.S. Food and Drug Administration (FDA)-approved POC hospital-calibrated glucose monitoring systems (39) (**Table 7.1**). POC blood glucose monitors provide the advantage of immediate bedside results, and studies suggest that while POC measurements are less accurate and less precise than those from laboratory glucose analyzers, they provide adequate information for usual practice except in rare instances where care has been compromised (40,41). Particular attention should be given to factors that may cause errors in POC measurement such as perfusion abnormalities, edema, anemia or erythrocytosis, and several medications commonly used in the hospital (39). The FDA has established standards for capillary (finger-stick) POC glucose monitoring in the hospital (39). The balance between analytic requirements (e.g., accuracy, precision, and interference) and clinical requirements (e.g., rapidity, simplicity, and POC) has not been uniformly resolved (39–42), and most hospitals 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, undergo careful analysis of performance and reliability and ongoing quality assessments (42). Best practice dictates that any POC glucose result that does not correlate with the individual's clinical status should be confirmed by repeating the test first and measuring a sample in the clinical laboratory if the second result is similar, particularly for asymptomatic hypoglycemic events.

Continuous Glucose Monitoring

Recommendations

16.6 In people with diabetes using a personal continuous glucose monitoring (CGM) device, the use of CGM should be continued during hospitalization if clinically appropriate, with confirmatory point-of-care (POC) blood glucose measurements for insulin dosing decisions and hypoglycemia assessment, if resources and training are available, and according to an institutional protocol. **B**

While supporting individuals who wish to continue use of personal continuous glucose monitoring (CGM) devices is encouraged, currently it is recommended that confirmatory POC be used for insulin dosing. However, a recent retrospective study demonstrated the feasibility of implementation of a hospital-wide personal CGM policy that included EHR integration and CGM validation for insulin dosing; the policy resulted in favorable hospitalized individual and nurse satisfaction (43). Validation criteria to ensure adequate accuracy of CGM have been based on a modified version of FDA criteria for integrated CGM devices. Known as the 20/20 criterion, it requires a CGM reading to be within ±20% of the POC measurement when blood glucose is ≥70 mg/dL or within ±20 mg/dL of the POC measurement when blood glucose is <70 mg/dL. Several other studies have demonstrated that inpatient use of hospital-owned CGM devices is feasible and has advantages over POC glucose monitoring in improving glycemic management, detecting hypoglycemia (particularly nocturnal, prolonged and/or asymptomatic hypoglycemia [44,45]), and reducing recurrent hypoglycemia (43,46–48). However, at this time, none of the CGM devices have been approved by the FDA for inpatient use. During the coronavirus disease 2019

(COVID-19) pandemic, many institutions used CGM in ICU and non-ICU settings, with the aim of minimizing exposure time and saving personal protective equipment, under an FDA policy of enforcement discretion (49,50). Data on the safety and efficacy of real-time CGM use in the hospital, particularly with implementation of remote monitoring (e.g., a glucose telemetry system), has grown (47,50–52). However, a recent multicenter randomized clinical trial did not show a benefit of using CGM over POC monitoring for insulin adjustment in individuals with type 2 diabetes hospitalized for noncritical illness (53). Both groups achieved similar mean blood glucose levels (170 ± 32 vs. 175 ± 33 [P = 0.25]) with similarly low levels of hypoglycemia. The discrepancies in the results of clinical trials may be related to treatment algorithms rather than the method of glucose monitoring. Before the COVID-19 pandemic, the use of hospital CGM was mostly restricted to remote monitoring and facilitation of insulin adjustment based on daily CGM data, rather than as a replacement for POC. However, hospital CGM was successfully used in conjunction with periodic POC monitoring in hybrid protocols used for intravenous insulin titrations, decreasing the burden of hourly POC testing (54–56).

Due to an ongoing interest in use of hospital CGM systems, a recent consensus on good practice points for use of CGM devices in hospital settings has been published (57). For more general information on CGM, see section 7, "Diabetes Technology."

Insulin Pump Use in the Hospital

Recommendation

16.7 Continue use of insulin pump including automated insulin delivery in people with diabetes who are hospitalized when clinically appropriate. This is contingent upon availability of necessary supplies, resources, training, ongoing competency assessments, and implementation of institutional diabetes technology protocols. **C**

Data on inpatient use of hybrid closed-loop systems (currently commercially available automated insulin delivery [AID] devices) are limited to feasibility trials (58). In a randomized controlled trial, people with type 2 diabetes receiving noncritical care had significantly better glycemia with the use of an automated, fully closed-loop insulin delivery system than with conventional subcutaneous insulin therapy, without a higher risk of hypoglycemia (59). Continuation of insulin pump or AID system use should be supported during hospitalization when clinically appropriate in individuals who are willing and able to self-manage their devices, with proper staff training and supervision. An observational study in children demonstrated improvement in individual satisfaction and improved detection of glycemic excursions with continued use of personal devices (60). Consultation with the endocrinology/diabetes care team or diabetes care and education specialists, if available, is recommended, especially if the reason for admission is suspected to be related to device malfunction or lack of adequate education, training, or use. Best practices ensuring safe use of AID systems in the hospital setting are evolving. Many institutions still require POC blood glucose monitoring with variable frequency (1–6 times daily) for individuals continuing insulin pump or AID system use. Since AID systems cannot function without using CGM data, it is important to ensure and document CGM accuracy by cross-checking CGM readings with POC or blood glucose readings periodically (at least once daily) or when clinically appropriate. To consider CGM readings valid, current criteria require a CGM reading to be within ±20% of POC or laboratory blood glucose measurement or within ±20 mg/dL when POC or laboratory blood glucose is ≤70 mg/dL (43). In addition, CGM and AID data should be reviewed and documented daily (e.g., before meals and at bedtime) and pump settings should be adjusted as needed to ensure that the individual is meeting treatment goals. Hospitals are encouraged to develop institutional policies and have available trained personnel with knowledge of diabetes technology. In a recent survey, less than half the hospitals had these policies in place (61).

For more general information on AID, see section 7, "Diabetes Technology."

GLUCOSE-LOWERING TREATMENT IN HOSPITALIZED INDIVDIUALS

An individualized approach for glycemic management is encouraged throughout the hospital stay and should take into consideration several predictive factors for achieving glycemic goals, such as prior home use and doses of insulin or noninsulin therapy, expected level of insulin resistance, prior A1C, current glucose levels, nutritional intake, duration of diabetes, glucose altering medications, and the goal of treatment for primary disease.

Insulin Therapy

Recommendations

16.8a Continuous intravenous insulin infusion is recommended for achieving glycemic goals and avoiding hypoglycemia in critically ill individuals. **A**

16.8b Basal insulin or a basal plus correction insulin plan is the preferred treatment for noncritically ill hospitalized individuals with poor or no oral intake. **A**

16.9 An insulin plan with basal, prandial, and correction components is the preferred treatment for most noncritically ill hospitalized individuals with adequate nutritional intake. **A**

16.10 For most individuals, sole use of a correction or supplemental insulin without basal insulin (formerly referred to as a sliding scale) in the inpatient setting is discouraged. **A**

Critical Care Setting

Continuous intravenous insulin infusion is the most effective method for achieving specific glycemic goals and avoiding hypoglycemia in the critical care setting. Intravenous insulin infusions should be administered using validated written or computerized protocols that allow for predefined adjustments in the insulin infusion rate based on glycemic fluctuations and immediate past and current insulin infusion rates (62). For individuals who are eating but continue to need intravenous insulin infusion, prandial coverage may be provided as rapid-acting insulin administered subcutaneously, as this would prevent large fluctuations in intravenous insulin requirement and subsequent hypoglycemia risk (63).

Transitioning From Intravenous to Subcutaneous Insulin

When discontinuing intravenous insulin, a transition protocol should be used. Subcutaneous basal insulin should be given 2 h before intravenous infusion is discontinued, with the aim of minimizing rebound hyperglycemia while the subcutaneous insulin achieves its effect (63).

Emerging data from studies in people with hyperglycemia with and without diabetic

ketoacidosis (DKA) show that the administration of a low dose (0.15–0.3 units/kg) of basal insulin analog in addition to intravenous insulin infusion may reduce the duration of insulin infusion and length of hospital stay and prevent rebound hyperglycemia without increased risk of hypoglycemia (64–67). This may be particularly beneficial for people with type 1 diabetes to minimize the risk for DKA should insulin infusion be stopped for a prolonged period of time.

For transitioning, the total daily dose of subcutaneous insulin may be calculated using a weight-based approach, based on prior home insulin dose or based on the insulin infusion rate during the prior 6–8 h when stable glycemic goals were achieved (12). It is important to ensure correct dosing either by either using an insulin pen or meticulous pharmacy and nursing supervision of the dose drawn from a vial.

Noncritical Care Setting

In most instances, insulin is the preferred treatment for hyperglycemia in hospitalized individuals. In certain circumstances, it may be appropriate to continue home oral glucose-lowering medications or initiate use of agents such as dipeptidyl peptidase 4 inhibitors (DPP-4i) for mild hyperglycemia.

Scheduled subcutaneous insulin orders are recommended for the management of hyperglycemia in people with diabetes and hyperglycemia. Use of insulin analogs or human insulin results in similar glycemic outcomes in the hospital setting, but human insulin may increase the risk of hypoglycemic events (68). The use of subcutaneous rapid- or short-acting correctional insulin before meals, or every 4–6 h if no meals are given or if the individual is receiving continuous enteral or parenteral nutrition, is indicated to correct or prevent hyperglycemia. Basal insulin, or a basal plus bolus correction schedule, is the preferred treatment for noncritically ill hospitalized individuals with inadequate or restricted oral intake. An insulin schedule with basal, prandial, and correction components is the preferred treatment formost noncritically ill hospitalized people with diabetes with adequate nutritional intake.

Typically, total daily insulin dose is calculated based on body weight and sensitivity to insulin, with 0.3–0.6 units/kg/day as the usual starting dose (69). Initial total daily insulin dose may also be estimated from the last 6–8 h of insulin infusion rate or the insulin dose received in previous hospitalization or calculated as 80% of the home insulin dose, as the situation applies. If calculating from the insulin infusion rate, about 60% of the calculated total daily dose should be used to account for glucotoxicity. Half of the estimated total daily insulin should be given as basal insulin and half as nutritional insulin. Correctional insulin scales should be proportional to the total daily dose of insulin e.g., low scale for insulin dose <40 units/day, medium for 40–80 units/day, and high for >80 units/day. Correctional insulin dosing should typically start at 140 or 150 mg/dL (7.8 or 8.3 mmol/L) for adequate glycemic management. Several reports indicate that inpatient use of insulin pens is safe and may improve nurse satisfaction when safety protocols, including nursing education and bar code scanning procedures, are in place to guarantee single-person use (70–73).

The decision to restart a home insulin plan upon hospitalization should take into account the individual's adoption of their insulin plan while at home as well as the change in their clinical status, including nutrition and kidney function.

A randomized controlled trial has shown that basal plus bolus insulin plan improved glycemic outcomes and reduced hospital complications compared with a correction or supplemental insulin without basal insulin (formerly known as sliding scale) for people with type 2 diabetes admitted for general surgery (74). Prolonged use of correction or supplemental insulin without basal insulin is strongly discouraged in the inpatient setting, with the exception of people with type 2 diabetes in noncritical care with mild hyperglycemia or stress hyperglycemia who maintain blood glucose <180 mg/dL (75,76).

A prospective randomized inpatient study of 70/30 intermediate-acting (NPH)/regular insulin mixture versus basal-bolus therapy showed comparable glycemic outcomes but significantly increased hypoglycemia in the group receiving the insulin mixture (77). Therefore, insulin mixtures such as 75/25, 70/30, or 50/50 insulins are not routinely recommended for in-hospital use.

Data on the use of concentrated insulins such as glargine U-300, degludec U-200, and U-500 regular insulin in the inpatient and perioperative settings are limited and have shown variable results (78–81). Hypoglycemia and dosing errors are a particular concern for individuals using U-500 insulin whose inpatient insulin needs are reduced up to 75% compared with home dosing regardless of preadmission glycemia (82). If concentrated insulin must be used in a specific situation, the risk of dosing errors can be reduced by using a pen device or having the dose drawn by a pharmacist. Consultation with a diabetes care team should be considered in this situation.

Type 1 Diabetes

For people with type 1 diabetes, correctional insulin alone is contraindicated because insulin dosing based solely on premeal glucose levels does not account for basal insulin requirements or caloric intake and increases the risk of both hypoglycemia and hyperglycemia (83). An insulin schedule with basal and correction components is necessary for all hospitalized individuals with type 1 diabetes, even for those taking nothing by mouth, with the addition of prandial insulin when individuals are eating. Policies and practice alerts in the EHR should be put in place to ensure that basal insulin (given subcutaneously, via insulin pump or by insulin infusion) is not held for people with type 1 diabetes, especially during care transitions, and that ongoing prescriber and nursing education is provided (71).

Noninsulin Therapies

Recommendation

16.11 It is recommended that use of a sodium–glucose cotransporter 2 inhibitor be initiated or continued during hospitalization if indicated for heart failure, providing there are no contraindications. **A**

While sodium–glucose cotransporter 2 (SGLT2) inhibitors are not recommended for glycemic management in the hospital setting, they may be initiated or continued for people with type 2 diabetes hospitalized with heart failure if there are no contraindications and after recovery from the acute illness (84–89). SGLT2 inhibitors should be avoided in cases of severe illness, in people with ketonemia or ketonuria, and during prolonged fasting and surgical procedures (90). Proactive adjustment of insulin and diuretic dosing is recommended during hospitalization and/or discharge, especially in collaboration with a cardiology/heart failure consultation team. It is recommended that

SGLT2 inhibitors be stopped 3 days before scheduled surgeries (4 days for ertugliflozin) (90).

A few randomized trials demonstrated the safety and efficacy of DPP-4i in specific groups of hospitalized people with diabetes (91–93). The use of DPP-4i with or without basal insulin may be a safer and simpler plan for people with mild to moderate hyperglycemia on admission (e.g., admission glucose <180–200 mg/dL), with reduced risk of hypoglycemia (91,92). However, the FDA states that health care professionals should consider discontinuing saxagliptin and alogliptin in people who develop heart failure (94). It is worth noting that in the case of linagliptin, no renal dose adjustment is required. Data on the inpatient use of glucagon-like peptide 1 receptor agonists (GLP-1 RAs) are still mostly limited to research studies and select populations that are medically stable (95,96). Therefore, GLP-1 RA drugs should be held for acutely ill individuals in the hospital setting.

HYPOGLYCEMIA

Recommendations

16.12 A hypoglycemia management protocol should be adopted by all health systems. A plan for identifying, treating, and preventing hypoglycemia should be established for each individual. Episodes of hypoglycemia in the hospital should be documented in the health record and tracked to inform quality improvements. **C**

16.13 Treatment plans should be reviewed and changed as necessary to prevent hypoglycemia and recurrent hypoglycemia when a blood glucose value of <70 mg/dL (<3.9 mmol/L) is documented. **C**

People with or without diabetes may experience hypoglycemia in the hospital setting. While hypoglycemia is associated with increased mortality (97,98), in many cases, it is a marker of an 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 during hospitalization. Many episodes of inpatient hypoglycemia are preventable. 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 <70 mg/dL (<3.9 mmol/L) (99,100). In addition, individualized plans for preventing and treating hypoglycemia for each person should also be developed. The treatment plan should be reviewed any time a blood glucose value of <70 mg/dL (<3.9 mmol/L) occurs, as this level often predicts subsequent level 3 hypoglycemia. Episodes of hypoglycemia in the hospital should be documented in the EHR and tracked (101). A key strategy is embedding hypoglycemia treatment into all insulin and insulin infusion orders.

Inpatient Hypoglycemia: Risk Factors, Treatment, and Prevention

Insulin is one of the most common medications that causes adverse events in hospitalized individuals. Errors in insulin dosing, missed doses, and/or administration errors including incorrect insulin type and/or timing of dose occur relatively frequently (102–104) and include prescriber (ordering), pharmacy (dispensing), and nursing (administration) errors. Common preventable sources of iatrogenic hypoglycemia are improper prescribing of other glucose-lowering medications and inappropriate management and follow-up of the first episode of hypoglycemia . Kidney failure is an important risk factor for hypoglycemia in the hospital (105), possibly as a result of decreased insulin clearance. Other related factors for hypoglycemia include advanced age, comorbidities including heart and liver failure, sepsis, and malnutrition, among others (106). Studies of "bundled" preventive therapies, including proactive surveillance of glycemic outliers and an interprofessional data-driven approach to glycemic management, showed that hypoglycemic episodes in the hospital could be reduced or prevented (107,108). Compared with baseline, studies found that hypoglycemic events decreased by 56–80% (100,107,108). The Joint Commission, a quality improvement and patient safety in health care organization, recommends that all hypoglycemic episodes be evaluated for a root cause and the episodes be aggregated and reviewed to address systemic issues and possible solutions (26).

In addition to errors with insulin treatment, iatrogenic hypoglycemia may occur after a sudden reduction of corticosteroid dose, reduced oral intake, emesis, inappropriate timing of short- or rapid-acting insulin doses in relation to meals, reduced infusion rate of intravenous dextrose, unexpected interruption of enteral or parenteral feedings, prolonged procedures or surgery, delayed or missed blood glucose checks, and altered ability of the individual to report symptoms.

Studies show promise for CGM to alert the wearer or care staff of impending hypoglycemia, offering an opportunity to mitigate it before it happens (46,48). The use of personal CGM and AID devices may also help avoid hypoglycemia. Thus, the use of diabetes technology may help reduce the risk of hypoglycemia in future.

Treatment of hypoglycemia includes administering 15 g of fast-acting carbohydrate (to those who can swallow and do not have NPO status) or administering intravenous glucose or glucagon. Blood glucose should be monitored every 15 min and treatment hypoglycemia repeated until it is stabilized above 70 mg/dL (3.9 mmol/L).

Predicting and Preventing Severe Hypoglycemia

In people with diabetes, it is well established that an episode of severe hypoglycemia increases the risk for a subsequent event, partly because of impaired counterregulation (109). In a study of hospitalized individuals, 84% of people 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 (110). In another study of hypoglycemic episodes (defined as <50 mg/dL [<2.8 mmol/L]), 78% of individuals were taking basal insulin, with the incidence of hypoglycemia peaking between midnight and 6:00 A.M. (111). Despite recognition of hypoglycemia, 75% of individuals did not have their dose of basal insulin changed before the next basal insulin administration (111). Several groups have developed algorithms to predict episodes of hypoglycemia in the inpatient setting (112,113). Models such as these are potentially important and, once validated for general use, could provide a valuable tool to reduce rates of hypoglycemia in the hospital. In one retrospective cohort study, a fasting blood glucose of <100 mg/dL was shown to be a predictor of next-day hypoglycemia (38).

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 outcomes, address personal food preferences, and facilitate the 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. Controlled carbohydrate meal plans, where the amount of carbohydrate on each meal tray is calculated, are preferred by many hospitals, as they facilitate matching the prandial insulin dose to the amount of carbohydrate given (114). Orders should also indicate that the glucose check, meal delivery, and nutritional insulin coverage should be coordinated—a concept also known as a "meal triad"—as their variability often creates the possibility of hyperglycemic and hypoglycemic events (20). Some hospitals offer "meals on demand," where individuals may order meals from the menu at any time during the day. This option improves patient satisfaction with hospital but complicates glucose monitoring–insulin–meal coordination and can lead to insulin stacking if meals are too close together (115). Finally, if the hospital food service supports carbohydrate counting, this option should be made available to people with diabetes counting carbohydrates at home, especially people wearing insulin pumps (115,116).

SELF-MANAGEMENT IN THE HOSPITAL

Diabetes self-management in the hospital may be appropriate for select individuals who wish to continue to perform self-care while acutely ill (117–119). Candidates include children with parental supervision, adolescents, and adults who successfully perform diabetes self-management at home and whose cognitive and physical skills needed to successfully self-administer insulin and perform glucose monitoring are not compromised by acute illness or delirium (7). In addition, they should have adequate oral intake and have stable insulin requirements. If self-management is supported, a policy should include a requirement that people with diabetes and the care team agree on a daily basis during hospitalization that self-management is appropriate. Hospital personal medication policies may include guidance for people with diabetes who wish to take their own or hospital-dispensed insulin and noninsulin medications during their hospital stay. A hospital policy for personal medication may include a pharmacy exception on a case-by-case basis as determined in consultation with the care team. Pharmacy must verify any home medication and require a prescriber order for the individual to self-administer home or hospital-dispensed medication under the supervision of the registered nurse. If an insulin pump or CGM device is worn, hospital policy and procedures delineating guidelines for wearing an insulin pump and/or CGM device should be developed according to consensus guidelines, including the changing of insulin infusion sites and CGM glucose sensors (120).

STANDARDS FOR SPECIAL SITUATIONS

Enteral and Parenteral Feedings

For individuals receiving enteral or parenteral nutrition who require insulin, the insulin orders should include coverage of basal, prandial, and correctional needs (115). It is essential that people with type 1 diabetes continue to receive basal insulin even if feedings are discontinued.

Commercially available enteral nutrition preparations contain variable amounts of carbohydrates and may be infused at different rates (116) that may affect nutritional insulin needs. Most adults receiving basal insulin should continue with their basal dose, while the insulin dose for the total daily nutritional component may be calculated as 1 unit of insulin for every 10–15 g of carbohydrate in the enteral and parenteral formulations. To avoid hypoglycemia, it is important not to cover all insulin needs using basal insulin only. Rapid-acting insulin every 4 h, regular insulin every 6 h, or NPH insulin every 8–12 h are options for coverage of nutritional needs during continuous administration of enteral tube feeds. However, a regular insulin–based plan has been associated with better glycemic management with fewer daily injections in individuals receiving continuous tube feeds (121). An automated self-adjusting insulin algorithm was shown to be safe and effective in controlling hyperglycemia in hospitalized individuals receiving enteral nutrition or total parenteral nutrition (122). Correctional insulin should also be administered subcutaneously every 6 h with regular human insulin or rapid-acting insulin every 4 h. If enteral nutrition is interrupted, intravenous dextrose may be given for duration of active insulin time.

For adults receiving enteral bolus feedings, approximately 1 unit of rapid-acting insulin per every 10–15 g of carbohydrate should be given subcutaneously before each feeding. To mitigate any hyperglycemia, correctional insulin should be added as needed before each feeding.

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

For individuals receiving continuous peripheral or central parenteral nutrition, human regular insulin may be added to the total parenteral nutrition solution, particularly if >20 units of correctional insulin have been required in the past 24 h. A starting dose of 1 unit of regular human insulin for every 10 g of dextrose has been recommended (115) 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, though subcutaneous insulin glargine has been shown to achieve equivalent management of glycemia (123). Correctional insulin should be administered subcutaneously to address any hyperglycemia.

Because continuous enteral or parenteral nutrition results in a continuous postprandial state, efforts to bring blood glucose levels to below 140 mg/dL (7.8 mmol/L) substantially increase the risk of hypoglycemia in these individuals.

Glucocorticoid Therapy

The prevalence of consistent use of glucocorticoid therapy in hospitalized individuals can approach 10–15%, and these medications can induce hyperglycemia in 56–86% of these individuals with and without preexisting diabetes (124–126). Glucocorticoid type and duration of action must be considered in determining appropriate insulin treatments. Daily-ingested intermediate-acting glucocorticoids such as prednisone reach peak plasma levels in 4–6 h but have pharmacologic actions that can last throughout the day. When

monitored by CGM, the typical glycemic pattern for individuals treated with daily prednisone or prednisolone, administered in the morning, is characterized by normal or mild fasting hyperglycemia, with trends of increasing hyperglycemia during the afternoon, and peaking in the evening. These hyperglycemic excursions are more pronounced in individuals with type 2 diabetes than in those without diabetes (127).

For individuals treated with once- or twice-daily steroids, administering NPH insulin with prednisone or prednisolone dosing is a frequently used approach, aimed at matching the NPH actions with the steroid-induced hyperglycemic response. NPH may be administered in addition to daily basal-bolus insulin or in addition to oral glucose-lowering medications, depending on the type of diabetes and recent diabetes medication prior to starting steroids (128). Because NPH action peaks about 4–6 h after administration, it is recommended that it be administered concomitantly with intermediate-acting steroids (129). For long-acting glucocorticoids such as dexamethasone and multidose or continuous glucocorticoid use, long-acting basal insulin may be required to manage fasting blood glucose levels. For higher doses of glucocorticoids, increasing doses of prandial (if eating) and correction insulin, sometimes as much as 40–60% or more, are often needed in addition to basal insulin (130,131). A retrospective study found that increasing the ratio of insulin to steroids was positively associated with improved time in range (70–180 mg/dL [3.9–10.0 mmol/L]); however, there was an increase in hypoglycemia (125). If insulin orders are initiated, daily adjustments based on levels of glycemia and anticipated changes in type, dosages, and duration of glucocorticoids, along with POC blood glucose monitoring, are critical to reducing hypoglycemia and hyperglycemia.

Perioperative Care

Recommendations

16.14 To improve postoperative outcomes after elective surgery, a preoperative A1C goal <8% (<64 mmol/mol) is recommended within 3 months, with individualized risk-to-benefit ratio assessment. **C** The 14-day glucose management indicator goal <8% and/or time in range >50% can also be used. **E**

16.15 Blood glucose before, during, and after surgery should be monitored and maintained between 100 and 180 mg/dL (5.6 and 10.0 mmol/L). Goals may differ depending on the surgery, risk for hypoglycemia, and glucose-lowering therapy. **E**

It is estimated that up to 20% of individuals undergoing major general surgery have diabetes, and 23–60% have prediabetes or undiagnosed diabetes. Surgical stress and counterregulatory hormone release increase the risk of hyperglycemia as well as mortality, infection, and length of stay (131,132). Perioperative hyperglycemia is a risk factor for postoperative infections and other complications (133,134). A meta-analysis showed that preoperative and perioperative hyperglycemia were associated with surgical site infections (135). The glycemic threshold for an increase in complications is estimated to be somewhere between 100 and 180 mg/dL (5.5 and 10 mmol/L) in most of these studies (135–138). Overall evidence supports preadmission treatment of hyperglycemia in people scheduled for elective surgery as an effective means of reducing adverse outcomes (139,140). Current data also suggest an optimal A1C goal between 7% and 8% preoperatively, as it is associated with better glycemic management in the perioperative period and decreased length of hospital stay (139,141–144). If available, 14-day CGM data with a glucose management indicator <8% or time in range >50% before elective surgery may be used in lieu of A1C as evidence of adequate preoperative glycemic management. However, due to lack of interventional data, postponing surgery based on A1C or glucose management indicator alone is not recommended, as it may lead to unnecessary delay or denying of required surgery. Some institutions have developed optimization programs to lower A1C prior to elective surgery. These programs have been shown to result in improved perioperative glycemic management and decreased length of hospital stay after surgery (139). In individuals undergoing noncardiac general surgery, basal insulin plus premeal short- or rapid-acting insulin (basal-bolus) coverage has been associated with improved glycemic outcomes and lower rates of perioperative complications compared with the reactive, correction-only short- or rapid-acting insulin coverage alone with no basal insulin dosing (74,145). In addition to glycemic goals, the following points need attention:

1. Stricter perioperative glycemic goals are not advised because they may not improve outcomes and are associated with increased hypoglycemia (146).
2. Blood glucose should be monitored at least every 2–4 h while the individual takes nothing by mouth, and insulin should be administered as needed. Insulin is the only recommended glucose-lowering medication in the perioperative period.
3. CGM should not be used alone for glucose monitoring during surgery (147).
4. Metformin and other oral glucose-lowering agents should be held on the day of surgery or procedure. See below for SGLT2 inhibitor and GLP-1 RA use in the perioperative period.
5. Individuals using an insulin pump may continue pump use during surgery if this is consistent with institutional policies and surgical procedures (148). This would require an interprofessional approach and adequate support systems in the hospital. If an insulin pump cannot be used during surgery, an alternative plan (insulin infusion or basal plus correctional insulin) should be initiated before surgery. Compared with usual dosing, a reduction of 25% of basal insulin dose given the evening before surgery is more likely to achieve perioperative blood glucose goals with a lower risk for hypoglycemia (149). Insulin dose reductions also include NPH insulin to one-half of the dose or long-acting basal insulin analogs to 75–80% of the dose or adjustment of insulin pump (if not in automated mode) basal rates based on the type of diabetes and clinical judgment. However, the decision needs to be individualized, as the dose reduction may not be appropriate for some people with type 1 diabetes.

SGLT2 Inhibitors in the Perioperative Period

SGLT2 inhibitors should be held for 3–4 days before elective surgery. Individuals using SGLT2 inhibitors who undergo nonelective surgeries should be closely

monitored for DKA after surgery; the possibility of euglycemic DKA should be considered.

The FDA advises considering temporary discontinuation of SGLT2 inhibitors at least 3 days prior to surgery and ensuring risk factors for ketoacidosis are resolved prior to reinitiating therapy. In a retrospective study of individuals with type 2 diabetes using SGLT2 inhibitors and requiring emergency surgery, the incidence of DKA was 4.9% for individuals using SGLT2 inhibitors and 3.5% for individuals not using SGLT2 inhibitors (150). After adjustment for covariates, the differences between the two groups were not statistically significant. However, because the diagnosis of DKA was based on an ICD-10 code, it is possible that some cases of DKA were missed in the SGLT2 inhibitor group, especially cases of euglycemic DKA. Other studies have shown a higher risk of DKA or anion gap acidosis associated with SGLT2 inhibitor use in the perioperative period (151–153). Therefore, until further prospective studies are conducted, as an abundance of caution, SGLT2 inhibitors should be held for 3–4 days before surgery. The medication may be restarted in the hospital setting for heart failure indication when nutritional intake is resumed, as explained above.

GLP-1 or Dual GIP and GLP-1 RAs and the Perioperative Period

With increasing use of GLP-1–based medications, there are concerns about the safety of these medications in the perioperative period. These medications may be associated with nausea, vomiting, and delayed gastric emptying, and there have been case reports of pulmonary aspiration during general anesthesia and deep sedation (154). Individuals taking a GLP-1 RA medication have higher chances of increased residual gastric content despite fasting for the procedure as needed (155). Based on these reports, FDA added a warning to the label of all GLP-1 RA or dual glucose-dependent insulinotropic polypeptide (GIP) and GLP-1 RA medications about the possibility of pulmonary aspiration during surgeries or procedures requiring general anesthesia or deep sedation (156). However, there is insufficient information on how to mitigate the risk of pulmonary aspiration in this situation. Even if the medication is held, the duration required to withhold the medication is unknown because 1 week of holding a once-weekly medication is likely insufficient to mitigate the risk (157). In a retrospective study, withholding semaglutide up to 30 days (with an average of 10 days) was still associated with increased residual gastric content (158).

The risk of aspiration pneumonia with increased gastric content in this setting is still unknown. In some retrospective studies, no increase in risk of aspiration pneumonia was found in association with GLP-1 RAs (159,160). The American Society of Anesthesiologists initially recommended holding GLP-1 RAs on the day of the procedure or surgery for daily dose agents and for at least 7 days prior to the procedure or surgery for once-weekly dose agents (161). However, more recently, multiple societies and expert groups have advised a more personalized approach, allowing individuals at low risk for delayed stomach emptying who undergo elective surgery to continue taking their GLP-1 RA medications and suggesting a liquid nutrition protocol for 24 h before the procedure or other measures for those at higher risk for significant gastrointestinal side effects (162–164).

A personalized approach for perioperative management of individuals taking a GLP-1 RA or a dual GIP and GLP-1 RA is recommended. Factors such as the primary indication of these medications (e.g., diabetes or obesity treatment); current glycemic management; dose, duration, and characteristics of the drug; gastrointestinal symptoms; type of surgery or procedure and its urgency; and type of anesthesia should be considered. In addition, a preoperative gastric ultrasound may be considered to quantify gastric contents. In individuals with symptoms suggesting delayed gastric emptying (nausea, vomiting, dyspepsia, or abdominal distension), implementation of full stomach precautions may be considered. A liquid nutrition protocol for 24 h before the procedure may be helpful. If a decision is made to hold the drug and worsening of glycemia is anticipated, an alternative strategy for perioperative glycemic management (e.g., insulin) should be implemented.

Diabetic Ketoacidosis and Hyperglycemic Hyperosmolar State

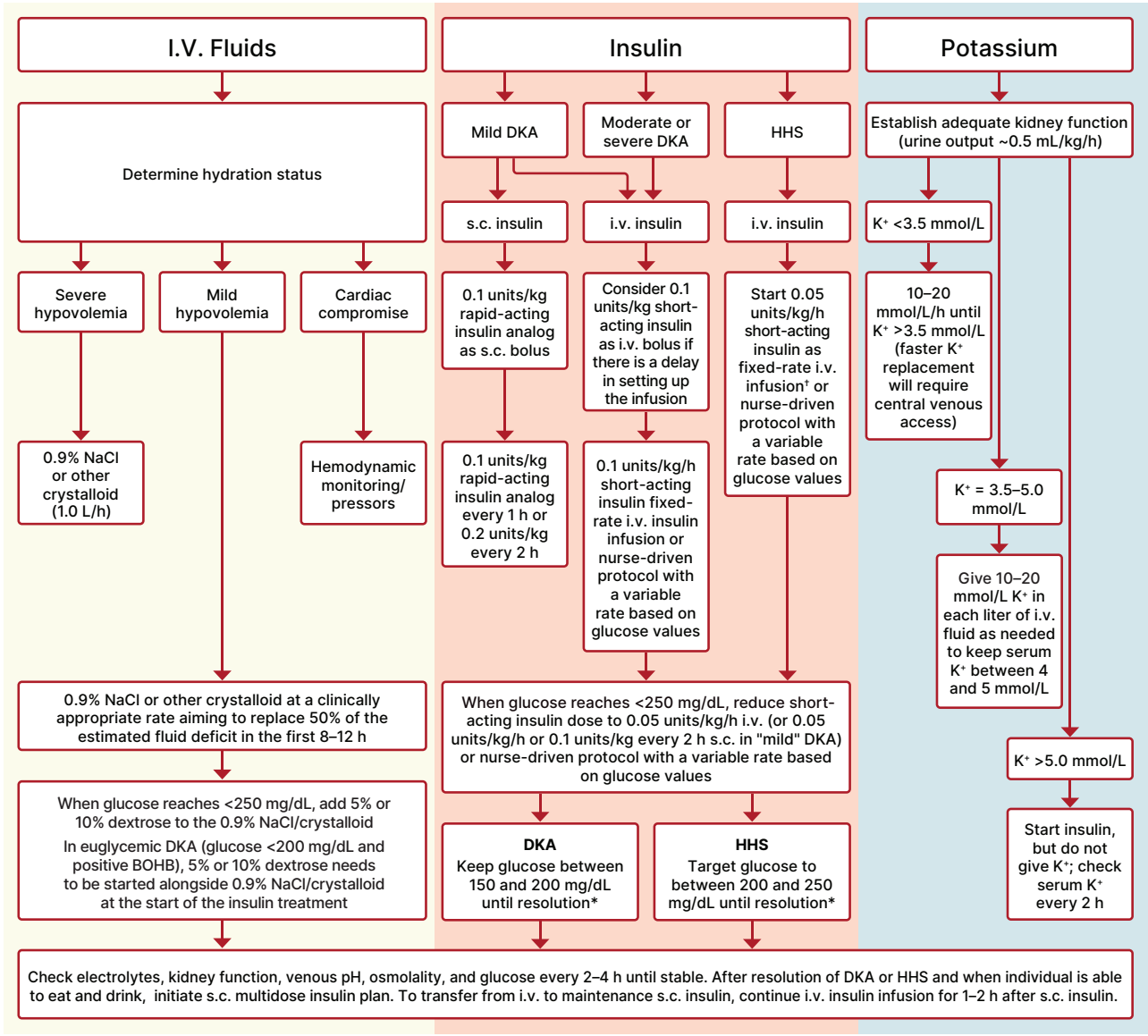
Recommendations

16.16 Manage diabetic ketoacidosis (DKA) and hyperglycemic hyperosmolar state (HHS) by administering intravenous fluids, insulin, and electrolytes (**Fig. 16.1**) and by closely monitoring during treatment, ensuring timely and bridged transition to maintenance subcutaneous insulin administration, and identifying and treating the precipitating cause. **A**

16.17 The discharge planning process should include education on the recognition, prevention, and management of DKA and/or HHS for all individuals affected by or at high risk for these events to prevent recurrence and readmission. **B**

DKA and the hyperglycemic hyperosmolar state (HHS) are serious, acute, and life-threatening hyperglycemic emergencies in individuals with diabetes (165) that incur substantial morbidity, mortality, and costs (166). Approximately 1% of all hospitalizations in people with diabetes are for hyperglycemic crises. The diagnostic criteria for DKA and HHS are summarized in **Table 16.1**; all criteria must be met to establish these diagnoses. Importantly, approximately 10% of people experiencing DKA present with euglycemic DKA (plasma glucose <200 mg/dL [<11.1 mmol/L]); therefore, DKA diagnosis requires either the presence of hyperglycemia or prior history of diabetes (165). Euglycemic DKA develops in the presence of low insulin levels and can be associated with a variety of factors including reduced food intake, pregnancy, alcohol use, liver failure, and/or SGLT2 inhibitor therapy (167). Additionally, DKA and HHS often present concurrently (168), though few studies have examined mixed DKA-HHS events.

There has been a concerning rise in the rate of hyperglycemic crises in people with both type 1 diabetes and type 2 diabetes over the past decade (169–171). Recent data suggest hyperglycemic crisis rates of up to 44.5–82.6 per 1,000 person-years among people with type 1 diabetes (169,172) and up to 3.2 per 1,000 person-years among people with type 2 diabetes (169). While DKA mortality decreased in the first decade of the 21st century (166), these improvements have plateaued in the past decade (170,172,173). Most recently available data for inpatient mortality during hospital admission for DKA ranges from 0.2% in type 1 diabetes (174) to 1.0% in type 2 diabetes (166,175). Inpatient mortality among people with type 2 diabetes hospitalized for HHS decreased from



† Some have recommended that insulin be withheld until glucose has stopped dropping with fluid administration alone.

* Definitions of resolution (use clinical judgment and do not delay discharge or level of care if these are not met):

- **DKA:** Venous pH >7.3 or bicarbonate >18 mmol/L and plasma/capillary ketones <0.6 mmol/L
- **HHS:** Calculated serum osmolality falls to <300 mOsm/kg and urine output is >0.5 mL/kg/h and glucose is <250 mg/dL

150 mg/dL = 8.3 mmol/L
200 mg/dL = 11.0 mmol/L
250 mg/dL = 13.9 mmol/L
300 mg/dL = 16.6 mmol/L

ⓘ **Bicarbonate should only be considered if pH is <7.0**

ⓘ **Phosphate should not be given unless there is muscle weakness, respiratory compromise, and a phosphate <1.0 mmol/L or <0.32 mmol/L**

Figure 16.1—Treatment pathways for diabetic ketoacidosis (DKA) and hyperglycemic hyperosmolar state (HHS). BOHB, β-hydroxybutyrate. Adapted from Umpierrez et al. (165).

1.44% in 2008 to 0.77% in 2018 (176). The only study to have examined inpatient mortality for mixed DKA-HHS found it to be higher than mortality for HHS or DKA alone (168). Mortality rates reported in low- and middle-income countries are much higher than those in developed countries, potentially because of delayed diagnosis and treatment (165). People discharged after an episode of DKA have a 1-year age-corrected mortality rate that is 13 times higher than the general population (177).

There is considerable variability in the presentation of DKA and HHS, including euglycemic DKA (defined as plasma glucose levels <200 mg/dL [<11.1 mmol/L] in the presence of ketosis and metabolic acidosis), mild to moderate hyperglycemia and acidosis, or severe hyperglycemia, dehydration, and coma; therefore, individualization of treatment based on a careful clinical and laboratory assessment is needed (165). Differences in the clinical presentation of DKS and HHS are shown in **Table 16.2**, though there is a considerable overlap.

Table 16.1—Diagnostic criteria for DKA and HHS

DKA	
Diabetes/hyperglycemia	Glucose ≥200 mg/dL (11.1 mmol/L) or prior history of diabetes
Ketosis	β-Hydroxybutyrate concentration ≥3.0 mmol/L or urine ketone strip 2+ or greater
Metabolic acidosis	pH <7.3 and/or bicarbonate concentration <18 mmol/L
HHS	
Hyperglycemia	Plasma glucose ≥600 mg/dL (33.3 mmol/L)
Hyperosmolarity	Calculated effective serum osmolality >300 mOsm/kg (calculated as [2 × Na^+ (mmol/L) + glucose (mmol/L)] or total serum osmolality >320 mOsm/kg [2 × Na^+ (mmol/L) + glucose (mmol/L) + urea (mmol/L)]
Absence of significant ketonemia	β-Hydroxybutyrate concentration <3.0 mmol/L OR urine ketone strip less than 2+
Absence of acidosis	pH ≥7.3 and bicarbonate concentration ≥15 mmol/L

Adapted from Umpierrez et al. (165).

Management goals include restoration of circulatory volume and tissue perfusion, resolution of ketoacidosis, and correction of electrolyte imbalance and acidosis. It is also essential to treat and manage any underlying cause of DKA, such as sepsis, myocardial infarction, or stroke. For severe DKA and HHS management, continuous intravenous insulin infusion should be given for correction of hyperglycemia, hyperketonemia, and acid-base disorder following a fixed-rate intravenous insulin infusion (165) or nurse-driven protocol with a variable rate based on glucose values (178). If a nurse-driven insulin infusion protocol is used, the infusion rate should be no less than 1 unit/h to allow for acidosis resolution. Successful transition from intravenous to subcutaneous insulin requires administration of basal insulin 2–4 h before the intravenous insulin is stopped to prevent recurrence of ketoacidosis and rebound hyperglycemia while the subcutaneous insulin action rises (63,179). Studies have reported that the administration of a low dose of basal insulin analog in addition to intravenous insulin infusion early in the course of treatment may prevent rebound hyperglycemia without increased risk of hypoglycemia (64–66,179). Individuals with mild and uncomplicated DKA can be managed with subcutaneous rapid-acting insulin doses given every 1–2 h (180), and this treatment may be administered in the emergency department or step-down units (181). This approach may be safer and more cost-effective than treatment with intravenous insulin. 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 (182). Therefore, if subcutaneous insulin administration is used, it is important to provide an adequate fluid replacement, frequent POC blood glucose monitoring, treatment of any concurrent infections, and appropriate follow-up to avoid recurrent DKA. Several studies have shown that the use of bicarbonate in people with DKA made no difference in the resolution of acidosis or time to discharge, and its use is generally not recommended. For further treatment information and in-depth review, refer to the ADA consensus report "Hyperglycemic Crises in Adults With Diabetes" (165).

TRANSITION FROM THE HOSPITAL TO THE AMBULATORY SETTING

Recommendation

16.18 A structured discharge plan should be tailored to the individual with diabetes. **B** For those not being discharged to home, consider the capabilities of the facility for diabetes management. **E**

A structured discharge plan tailored to the individual may reduce the length of hospital stay and readmission rates and increase satisfaction with the hospital experience (183). Multiple strategies are key, including diabetes self-management education prior to discharge, diabetes medication reconciliation with attention to access, affordability, and scheduled virtual and/or face-to-face follow-up visits after discharge. Discharge planning should begin at admission and be updated as individual needs change (184,185). Individualization and shared decision-making is key when creating a safe and effective discharge plan.

The transition from the acute care setting presents risks for all people with diabetes. Individuals may be discharged to varied settings, including home (with or without visiting nurse services), assisted living, rehabilitation, or skilled nursing facilities. For individuals discharged to home or assisted living, the optimal discharge plan will need to consider diabetes type and severity, effects of the

Table 16.2—Clinical presentation in people with diabetes with DKA and HHS

DKA	HHS
Develops over hours to days	Develops over days to a week
Usually alert	Change in cognitive state common
Polyuria, polydipsia, weight loss, and dehydration	
Nausea, vomiting, and abdominal pain	Often copresenting with other acute illness
Kussmaul respiration	
One-third of hyperglycemic emergencies have a hybrid DKA-HHS presentation	

Adapted from Umpierrez et al. (165).

illness on blood glucose levels, and the individual's circumstances, capabilities, and preferences as well as the facility-related capabilities to manage diabetes (21,186–188). See section 13, "Older Adults," for more information.

An outpatient follow-up visit with primary care, endocrinology, or a diabetes care and education specialist within 1 month of discharge is advised for all individuals experiencing hyperglycemia and/or hypoglycemia in the hospital. If glycemic management medications are changed or glucose management is not optimal at discharge, an earlier appointment (in 1–2 weeks) is preferred, and frequent contact to consider therapy adjustments may be needed to avoid hyperglycemia and hypoglycemia. A discharge algorithm for glycemic medication adjustment, based on admission A1C, diabetes medications before admission, and insulin usage during hospitalization was found useful to guide treatment decisions and significantly improved A1C after discharge (4).

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

The Agency for Healthcare Research and Quality recommends that, at a minimum, discharge plans include medication reconciliation, structured discharge communication, and education for the individual with diabetes (189).

Medication Reconciliation

- Home and hospital medications must be cross-checked to ensure the safety of new and old prescriptions, that no chronic medications are stopped, and that there is no duplication of medications under different brand names.
- Prescriptions for new or changed medications should be filled and reviewed with the individual and care partners at or before discharge whenever possible.

Structured Discharge Communication

- Information on medication changes, pending tests and studies, and follow-up needs must be accurately and promptly communicated to outpatient health care professionals.
- Discharge summaries should be transmitted to the primary care health care professional as soon as possible after discharge.
- Scheduling follow-up appointments prior to discharge with people with diabetes agreeing to the time and place increases the likelihood that they will attend.

Education for the Person With Diabetes

- Identify the health care professionals who will provide follow-up and diabetes care after discharge.
- Assess the level of understanding related to diabetes diagnosis, glucose monitoring, home glucose goals, and when to call a health care professional.
- Provide information on choosing healthy food at home and referral to an outpatient registered dietitian nutritionist or diabetes care and education specialist to guide individualization of the meal plan, if needed.
- Review when and how to take blood glucose-lowering medications, including insulin administration and noninsulin injectables.
- Review sick-day management (21,187).
- Review proper use and disposal of diabetes supplies, e.g., insulin pens, pen needles, syringes, glucose meters, and lancets.

People with diabetes must be provided with appropriate durable medical equipment, medications, supplies (e.g., blood glucose test strips or CGM sensors), prescriptions, and appropriate education at the time of discharge to avoid a potentially dangerous hiatus in care.

PREVENTING ADMISSIONS AND READMISSIONS

For people with diabetes, the hospital readmission rate is between 14% and 20%, which is nearly twice that for people without diabetes (184,190). This may result in increased diabetes distress and has significant financial implications. Of people with diabetes who are hospitalized, 30% have two or more days of hospital stays, and these admissions account for over 50% of hospital costs for diabetes (191). 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; factors that may reduce readmission rates include scheduled home health visits and timely ambulatory follow-up care (184,190). While there is no standardized protocol to prevent readmissions, several successful strategies have been reported that identify high-risk individuals and offer some possible solutions (184). To prevent readmissions, monitor insulin adjustments for individuals admitted with A1C >9% (>75 mmol/mol) (192) or DKA (193,194) and follow a transitional care model (195). For individuals hospitalized with severe hypoglycemia, impaired awareness of hypoglycemia, or high risk for hypoglycemia (kidney failure, intensive insulin management, frailty, inadequate support system, etc.), consider prescribing glucagon to treat any future severe hypoglycemia events (196). For people with diabetes and chronic kidney disease, collaborative person-centered medical homes may decrease risk-adjusted readmission rates (197). Since recent studies have shown that use of CGM may prevent emergency department visits and hospital admission in people with type 1 and type 2 diabetes, it may be beneficial to initiate CGM just prior to discharge to facilitate follow-up and possibly prevent acute diabetes-related complications and readmission (198).

Age is also an important risk factor in hospitalization and readmission among people with diabetes (refer to section 13, "Older Adults," for detailed information). Successful proactive care transitions from inpatient to outpatient settings are key strategies for preventing readmission and emergency department visits.

THE FUTURE

Inpatient diabetes management is challenging for hospitals, health care professionals, and people with diabetes, as acute illness increases the risk of both hypoglycemia and hyperglycemia. The use of decision support tools and practice advisories in the EHR has facilitated health care professionals following the recommendations in this standard of care. In addition, personal and hospital-owned diabetes devices and dosing algorithms are changing the way we provide care. Future enhancements will likely continue to improve the quality of care

we deliver in hospitals and in transitions from inpatient to outpatient.

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