Inpatient Diabetes Management in the Twenty-First Century

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KEYWORDS

• Inpatient diabetes management • Inpatient insulin management • Hospital
• Diabetes • Hyperglycemia • Corticosteroids • Enteral and parenteral nutrition
• Insulin pump

KEY POINTS

- In hospitalized critically ill and noncritically ill patients both hyperglycemia and hypoglycemia are associated with poor outcomes.
- Insulin in the form of long-acting, basal insulin and fast but short-acting nutritional and corrective insulin should be used in hospitalized patients with diabetes.
- The total daily insulin dose for each patient depends on their outpatient diabetes regimen, their hemoglobin A1c level before admission, current mode and state of nutrition, and presence or absence of corticosteroids.
- Computerized provider insulin order entry and the live availability of patients' glucose levels can greatly aid in optimizing glycemic management in the hospital.

RATIONALE

In hospitalized patients, both hyperglycemia and hypoglycemia have been associated with poor outcomes. During the inpatient period, hyperglycemia has been associated with increased risk of infection,[1,2] cardiovascular events,[3–5] and mortality.[6,7] It is also associated with longer length of hospital stay.[3,8,9] Hypoglycemia has also been associated with an increased risk of mortality.[10] Therefore, current evidence supports avoidance of both conditions among hospitalized patients whether they are admitted to critical care units or noncritical care units.[5,9,11]

GLUCOSE TARGETS IN NONCRITICALLY ILL PATIENTS

Unfortunately, because of the limited number of trials, optimal blood glucose (BG) targets are still debated.[12] Glucose targets recommended by the consensus guidelines

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issued jointly by the American Diabetes Association (ADA) and the American Association of Clinical Endocrinologists (AACE)[9] and separately by the Endocrine Society[5] are shown in **Table 1**. Higher BG targets can be set for those who are prone to hypoglycemia, have severe comorbidities, or are terminally ill.[11] However, even then, it is recommended that BG be kept less than 200 mg/dL in order to avoid symptomatic hyperglycemia.[11] The basal-bolus insulin doses should be reduced if BG decreases to less than 100 mg/dL, unless patients are clinically stable and had tight control before admission.[11]

DIABETES MANAGEMENT FOR NONCRITICALLY ILL HOSPITALIZED PATIENTS

In all patients with diabetes, hemoglobin A1c (A1C) should be checked on admission unless patients have a value within the past 3 months.[5,9,11] For patients without diabetes, who have random BG level exceeding 140 mg/dL whether in the emergency department or during hospitalization, A1C should be checked. If A1C is 6.5% or greater, it strongly suggests that diabetes preceded hospitalization.[11] If random BG is greater than 140 mg/dL but A1C is 6.4 or less, diabetes diagnosis cannot be totally excluded and an oral glucose tolerance test should be ordered after discharge.

Involvement of a diabetes educator early in the course of admission will help newly diagnosed patients learn essential skills such as glucose monitoring, prevention and management of hypoglycemia, and proper intake of oral antihyperglycemic medications.[9,11] The same is true for patients starting insulin for the first time, whereby involvement of a diabetes educator not only ensures they receive instructions and have hands-on practice on proper insulin injection technique but also may identify barriers to self-management, such as poor patient dexterity that precludes insulin self-administration. Knowledge of such barriers will allow for early involvement and teaching of the patients' caregiver or, if needed, a change in the patients' diabetes discharge plan to one that either the patients or their caregivers are able to execute. Early identification and management of these issues ensure safe and timely discharge.[13]

Medical Nutrition Therapy

Medical nutrition therapy is important for both outpatient and inpatient diabetes management. All patients with diabetes should be on a balanced, hypocaloric, and carbohydrate-consistent diet. If enteral nutrition is used, a diabetes-specific formula is preferred over standard formula. Carbohydrate consistency helps in proper matching of prandial insulin with carbohydrate content of the meals.[8] Carbohydrates should be from whole grains, vegetables, fruits, and low-fat dairy with restricted amounts of added sugar and sucrose-containing foods.[14]

Oral Antihyperglycemic Medications and Glucagon Like Peptide-1 Receptor Agonists

The most recent guidelines from the ADA, AACE, and Endocrine Society recommend against the inpatient use of oral antihyperglycemic medications or

Table 1
Blood glucose targets in inpatient setting for noncritically ill patients

Random or Bedtime	Fasting and Premeal	Hypoglycemia
<180 mg/dL	100–140 mg/dL	<70 mg/dL

Data from Moghissi ES, Korytkowski MT, DiNardo M, et al. American Association of Clinical Endocrinologists and American Diabetes Association consensus statement on inpatient glycemic control. Diabetes Care 2009;32(6):1119–31.