SUMMARY

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Inpatient Management of Diabetes: An Increasing Challenge to the Hospitalist Physician

In this supplement, "Avoiding Complications in the Hospitalized Patient: The Case for Tight Glycemic Control," Dr. Susan S. Braithwaite defines specific populations, disorders, and hospital settings for which there now is strong evidence supporting the belief that short-term glycemic control will affect outcomes during the course of hospital treatment.[1] She provides a comprehensive summary of key studies showing the benefits of tight glycemic control in hospitalized patients. Dr. James S. Krinsley reviews the evidence that supports more intensive glucose control, along with a "real-world" success story that demonstrates how to apply the new glycemic targets in a multidisciplinary performance improvement project.[2] He discusses important issues surrounding the successful implementation of a tight glycemic control protocol, including barriers to implementation, setting the glycemic target, and tips for choosing the right protocol. Dr. Franklin Michota describes a practical guideline for how to implement a more physiologic and sensible insulin regimen for management of inpatient hyperglycemia.[3] He reports on the disadvantages of the sliding scale and recommends the implementation of a standardized subcutaneous insulin order set with the use of scheduled basal and nutritional insulin in the inpatient management of diabetes. Drs. Asudani and Calles-Escandon focus on the management of non–critically ill patients with hyperglycemia in medical and surgical units.[4] They propose a successful insulin regimen to be used in non-ICU settings that is based on the combined use of basal, alimentary (prandial), and corrective insulin. This supplement provides the hospitalist physician with the necessary tools to implement glycemic control programs in critical care and non–critical care units and can be summarized as follows.

Hyperglycemia in hospitalized patients is a common, serious, and costly health care problem with profound medical consequences. Thirty-eight percent of patients admitted to the hospital have hyperglycemia, about one third of whom have no history of diabetes before admission.[5] Increasing evidence indicates that the development of hyperglycemia during acute medical or surgical illness is not a physiologic or benign condition but is a marker of poor clinical outcome and mortality.[5–10] Evidence from observational studies indicates that the development of hyperglycemia in critical illness is associated with an increased risk of complications and mortality, a longer hospital stay, a higher rate of admission to the ICU, and a higher likelihood that transitional or nursing home

care after hospital discharge will be required.[5,7,9–14] Prospective randomized trials with critical care patients have shown that aggressive glycemic control reduces short- and long-term mortality, multiorgan failure, systemic infections, and length of hospital and ICU stays[7,9-11] and lower the total cost of hospitalization.[15] Controlling hyperglycemia is also important for adult patients admitted to general surgical and medical wards. In such patients, the presence of hyperglycemia is associated with prolonged hospital stay, infection, disability after hospital discharge, and death.[5,11,16]

Insulin, given either intravenously as a continuous infusion or subcutaneously, is currently the only available agent for effectively controlling glycemia in the hospital. In the critical care setting, a variety of intravenous infusion protocols have been shown to be effective in achieving glycemic control with a low-rate of hypoglycemic events and in improving hospital outcomes.[17–23] However, no prospective and randomized interventional studies have focused on the optimal management of hyperglycemia and its effect on clinical outcome among non–critically ill patients admitted to general medicine services. Fear of hypoglycemia leads physicians to inappropriately hold to their patients' previous outpatient diabetic regimens and to initiate "sliding-scale" insulin coverage, a practice associated with limited therapeutic success.[20,24,25] The most physiologic and effective insulin therapy provides both basal and nutritional insulin.[11] The basal insulin requirement is the amount of exogenous insulin necessary to regulate hepatic glucose production and peripheral glucose uptake and to prevent ketogenesis. The nutritional, or prandial, insulin requirement is the amount of insulin necessary to cover meals and the administration of intravenous dextrose, TPN, and enteral feedings. Prandial or mealtime insulin replacement has its main effect on peripheral glucose disposal. In addition to the basal and nutritional insulin requirements, patients often require supplemental or correction doses of insulin to treat unexpected hyperglycemia. The supplemental algorithm should not be confused with the sliding scale, which traditionally has been used alone, with no scheduled dose. Insulins used for basal requirements are NPH (which is intermediate acting) and long-acting insulin analogues (glargine and detemir). To cover nutritional need, regular insulin or rapid-acting analogues (lispro, aspart, glulisine) can be used. Although no inpatient controlled trials using the basal-nutritional insulin regimen have been reported, the use of basal and nutritional insulin regimen may be a better alternative to the use of intermediate insulin (NPH) and regular insulin in hospitalized patients.

Hypoglycemia in hospitalized patients with diabetes is a concern, and it has been a major barrier to aggressive treatment of hyperglycemia in the hospital. Severe hypoglycemia, defined as a glucose level less than 40 mg/dL, occurred at least once in 5.1% of patients in the intensively treated group in Van den Berghe's surgical ICU study, versus 0.8% of patients in the conventionally treated group.[19] The incidence of severe hypoglycemia ($<$40 mg/dL) reported by Krinsley et al. prior to institution of the intensified protocol was 0.35% of all values obtained, compared to 0.34% of those obtained during the treatment period, again without any overt adverse consequences.[26] Factors that increase the risk of hypoglycemia in the hospital include inadequate glucose monitoring, lack of clear communication or coordination between the dietary team, transportation, and nursing staff, and indecipherable orders. Clear algorithms for insulin orders and clear hypoglycemia protocols are critical to preventing hypoglycemia.

What should the target blood glucose level be in non–critically ill patients with diabetes? A recent position statement of the American Association of Clinical Endocrinology with cosponsorship by the American Diabetes Association, the American Heart Association, the American Society of Anesthesiologists, the Endocrine Society, the Society of Critical Care Medicine, the Society of Hospital Medicine, the Society of Thoracic Surgeons, and the American Association of Diabetes Educators[27] recommended a glycemic target between 80 and 110 mg/dL for hospitalized patients in the intensive care unit and a preprandial glucose goal of less than 110 mg/dL and a random glucose less than 180 mg/dL for patients in non–critical care settings. The Joint Commission on Accreditation of Healthcare Organization recently proposed tight glucose control for the critically ill as a core quality of care measure for all U.S. hospitals that participate in the Medicare program (www.jcaho.org). Recently, some experts have endorsed a more conservative blood glucose value, up to 140 mg/dL[26,28] or even higher, if the patient is not in a critical care unit. Until clinical recommendations supported by prospective randomized trials become available, it is prudent to approach management of hospitalized patients

with caution, but with the understanding that any blood glucose threshold greater than 140 mg/dL in the ICU and greater than 180 mg/dL in non–critical care areas should be avoided.

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