Case Study Responses

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Note: Readers are encouraged to visit www.InsulinJournal.com to review the details of a Case Study published in the January 2007 issue of *Insulin*.

This was the case of a 30-year-old Hispanic man who had been admitted to the surgical intensive care unit (ICU) with abdominal pain, vomiting, and a blood glucose level of 426 mg/dL.

Question 1. What medication should be started now to control this patient's hyperglycemia?
Answer: d. Continuous IV insulin infusion titrated to normalize blood glucose.

Intensive glycemic control with insulin has been found to improve outcomes in surgical ICU patients. IV insulin has a half-life of 5 to 9 minutes; thus, adjustments in response to hyperglycemia, hypoglycemia, and changes in the condition of patients are easier with this route of administration. In addition, circulatory status can affect the absorption of SC insulin in critically ill patients; response to IV insulin is therefore more predictable in this setting. IV insulin will also lead to a more rapid control of glucose levels and will help in estimating the dose of SC insulin that may be required later during hospitalization. Thus, a continuous IV insulin infusion should be used to control glucose levels in this patient. Sliding-scale insulin alone is not effective in achieving continuous normoglycemia and therefore is not appropriate in this setting. Insulin glargine and sliding-scale insulin could be used later during hospitalization (ie, once the patient is stable, and there is an estimate of his insulin requirements). Premixed insulin will have the same disadvantages as an SC insulin regimen and should not be used in subjects who can taking nothing by mouth. If insulin is still required at discharge, the patient could be given a premixed insulin regimen.

Question 2. What is your target blood glucose level in ICU patients?
Answer: c. Fasting blood glucose level of 80 to 110 mg/dL.

One randomized clinical trial has shown a reduction in mortality and morbidity in the surgical ICU with maintenance of fasting blood glucose between 80 and 110 mg/dL, and current guidelines from the American College of Clinical Endocrinologists and the American Diabetes Association recommend target glucose levels of 80 to 110 mg/dL in the critical care setting. There is some evidence that mortality rates in the ICU are high when the threshold glucose level is >140 mg/dL. In addition, because interventions to maintain glucose between 80 and 110 mg/dL increase the risk of hypoglycemia, some investigators suggest targeting glucose between 110 and 140 mg/dL while awaiting evidence from ongoing randomized clinical trials. Although a precise glucose target in ICU patients remains controversial, a blood glucose level of 200 mg/dL—which formerly was the conventional target level—is no longer appropriate in the ICU, as this level of glucose has been associated with worse outcomes in this setting. A target of fasting glucose <120 mg/dL and 2 hours postmeal <180 mg/dL is appropriate in the outpatient setting and in stable patients in general medicine and surgical departments but not in the ICU.

Question 3. Apart from reduction in blood glucose level, what other benefit can be expected in this patient from the regimen prescribed?
Answer: d. All of the above.

Insulin has been shown to have anti-inflammatory, antioxidant, profibrinolytic, and antithrombotic effects. Insulin reportedly has a platelet antiaggregatory effect as well. Hyperglycemia has a deleterious impact on the hemodynamic, vascular, and immune systems, and intensive glycemic control with insulin has been found to reduce the length of stay in the ICU and hospital. Insulin therapy, with the resulting control of glucose, is also effective in lowering triglyceride levels.

Question 4. How will you start insulin infusion in this patient and modify the treatment of diabetes mellitus once the patient's acute pancreatitis resolves? How often will you check his blood glucose level, and what precautions will you take to avoid hypoglycemia?
Answer: There are many protocols available to start insulin infusion in the ICU setting. In these protocols, insulin infusion is initiated according to the preliminary blood glucose reading and titrated based on ambient blood glucose and the rate of fall or increase in glucose concentrations over a 1- to 2-hour period. Initially,

blood glucose is checked every hour; once glucose levels and the patient's condition are stable, the frequency of blood glucose monitoring is increased to 2 to 4 hours. Blood glucose is checked with a bedside glucometer using capillary, venous, or arterial samples.

This patient has been diagnosed with new-onset diabetes mellitus because his blood glucose levels are high and his glycosylated hemoglobin level is 11.2%, suggesting that this hyperglycemia is chronic and not just secondary to his pancreatitis, which can transiently affect insulin secretory capacity. He is obese and probably has insulin resistance; because we are unsure of his endogenous insulin secretion at this point, he should be continued on an SC insulin regimen with oral agents to reduce insulin resistance once his acute pancreatitis resolves.

Potential SC insulin regimens include basal therapy alone, premixed or self-mixed insulin twice daily, and basal and bolus therapy by multiple SC injections or by continuous SC insulin infusion pump. Once the patient's pancreatitis resolves, he could be started on basal therapy with insulin glargine or detemir along with a sliding-scale rapid-acting insulin analogue (lispro, aspart, or glulisine) if his oral intake is poor, or standardized doses of rapid-acting insulin at meals if oral intake is predictable. Insulin doses could be estimated from the IV insulin infusion rates that were maintaining blood glucose. We suggest taking the mean IV insulin infusion rate over 4 hours and multiplying it by 20 to determine the total daily basal insulin requirement. This dose can be given at bedtime, and the IV insulin should be stopped 3 hours after the SC injection. Depending on the patient's oral intake, the rapid-acting insulin dose should be 10% to 50% of the basal insulin dose divided among breakfast, lunch, and dinner. A correction scale of rapid-acting insulin should be added to mealtime doses and at bedtime and 2 AM, depending on the patient's insulin sensitivity. Blood glucose should be checked premeals, at bedtime, and at 2 AM, and the insulin dose titrated to maintain a preprandial blood glucose level of 110 mg/dL and a maximal glucose level of 180 mg/dL.

When adjusting the insulin regimen, consideration should be given to the patient's hepatic and renal function, as well as to his age. The need for continuing insulin therapy should be assessed at discharge, and the insulin regimen prescribed must take into account the patient's capability for handling more complex regimens.

The achievement of these goals and the reduction of hypoglycemic episodes require adequate staffing and coordination of finger-stick glucose checks and administration of insulin. Successful implementation of these insulin regimens also requires coordination with the pharmacy, as well as education and training of nurses who conduct these protocols.

Readers are invited to consider a new Case Study (see page 97) and submit responses to www.InsulinJournal.com before the deadline.