Perioperative Management of Hyperglycemia and Diabetes in Cardiac Surgery Patients

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KEYWORDS

• Perioperative hyperglycemia • Diabetes • Cardiac surgery • Stress hyperglycemia
• Hospital diabetes • CABG

KEY POINTS

- Perioperative hyperglycemia is common after cardiac surgery and is associated with higher health care resource utilization, longer length of stay, and greater perioperative mortality.
- Improvement in glycemic control, in patients with stress hyperglycemia and diabetes, has a positive impact on morbidity and mortality.
- A target blood glucose level between 140 mg/dL and 180 mg/dL is recommended for most patients during the perioperative period.
- Insulin given by continuous insulin infusion is the preferred regimen for treating hyperglycemia in critically ill patients.
- Subcutaneous administration of basal bolus or basal plus correctional bolus is the preferred treatment of non–critically ill patients.

INTRODUCTION

The prevalence of diabetes mellitus is rising at an alarming rate, affecting 415 million people worldwide and approximately 30 million people in the United States in 2015.[1] Approximately half a million patients undergo coronary artery bypass graft surgery (CABG) each year in the United States.[2] Nearly 30% to 40% of patients undergoing

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cardiac surgery have a history of diabetes[3,4] and approximately 60% of patients without diabetes develop stress hyperglycemia, defined as a blood glucose greater than 140 mg/dL.[5–7]

Numerous studies have reported that, in critically ill and cardiac surgery patients, those who develop hyperglycemia are at increased risk for morbidity and mortality.[7–16] Perioperative hyperglycemia, in patients with and without diabetes, is associated with higher rates of wound infections, acute renal failure, longer hospital stay, and higher perioperative mortality compared with those without hyperglycemia.[8–13] Patients without diabetes who develop stress hyperglycemia during CABG surgery[14] or during intensive care unit (ICU) stay[15] have worse outcomes compared with those with previous history of diabetes. Stress hyperglycemia in patients without diabetes undergoing surgery has been associated with up to a 4-fold increase in complications and a 2-fold increase in death compared with patients with normoglycemia[16–18] and to subjects with diabetes.[16,19–24]

Stress mediators, namely stress hormones and cytokines, and the central nervous system interfere with insulin secretion and action leading to increased hepatic glucose production and reduced glucose uptake in peripheral tissues.[25,26] The adverse outcomes associated with hyperglycemia may be attributed to hyperglycemia-induced inflammatory and oxidative stress as well as its prothrombotic and vascular abnormalities. This article discusses the pathophysiology of stress-induced hyperglycemia, the impact of hyperglycemia on clinical outcomes, and strategies for the management of hyperglycemia and diabetes in cardiac surgery patients with and without a history of diabetes.

EPIDEMIOLOGY OF STRESS HYPERGLYCEMIA

Hyperglycemia, defined as a blood glucose level greater than 140 mg/dL, is common in critically ill and cardiac surgery patients, reported in 60% to 80% of cardiac surgery patients[5–7] and in and 40% to 60% of general ICU patients.[24,27–29] Most critically ill and cardiac surgery patients with hyperglycemia have a previous diagnosis of diabetes.[12,24] Most patients with diabetes experience worsening glycemic control due to the stress of surgery and anesthesia or the use of corticosteroids and nutritional support.[30] 40% to 60% of patients without a history of diabetes experience transient hyperglycemia due to the stress of surgery,[31–33] which resolves in many patients at the time of discharge. A third group of patients with inpatient hyperglycemia includes those who are newly diagnosed during hospitalization.[33–36] Thus, all patients admitted to the hospital should undergo laboratory glucose testing. Subjects without a history of diabetes with blood glucose greater than 140 mg/dL should have bedside point-of-care glucose testing.[37–39] In patients with hyperglycemia, measurement of hemoglobin A_{1c} (HbA_{1c}) differentiates stress hyperglycemia from diabetes in those who were previously undiagnosed.[32,33] The American Diabetes Association and Endocrine Society guidelines indicate that patients with hyperglycemia and an HbA_{1c} of 6.5% or higher can be classified as having diabetes.[37] It is important to emphasize, however, that despite a high specificity (100%), the HbA_{1c} cutoff of greater than 6.5% has a poor sensitivity (57%)[32] and its use is limited in patients with hemoglobinopathies, recent blood transfusion, severe kidney or liver disease, high-dose of salicylates, pregnancy, and iron deficiency anemia.[40] It is important to identify and track patients with stress hyperglycemia, because up to 60% of patients may have confirmed diabetes after 1 year of follow-up.[32]

REGULATION OF BLOOD GLUCOSE IN HEALTHY INDIVIDUALS AND DURING STRESS

Maintenance of normoglycemia is essential for normal physiology in the body and is maintained by dynamic, minute-to-minute regulation of endogenous glucose