Optimal Glucose Management in the Perioperative Period

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KEYWORDS

• Blood glucose • Glucose management • Glycemic control • Hyperglycemia
• Hypoglycemia • Perioperative • Surgical • Tight glycemic control

KEY POINTS

- Hyperglycemia, defined as a level of blood glucose (BG) greater than 180 mg/dL, in the perioperative period is associated with poor clinical outcomes; treating hyperglycemia in critically ill patients can lead to decreased morbidity and mortality.
- The gold standard for BG measurement is a venous plasma sample evaluated through the clinical laboratory.
- Intensive insulin therapy, defined as a target treatment BG range of 80 to 110 mg/dL, significantly increases the incidence of hypoglycemia and has not been proven to be beneficial in surgical patients.
- When determining when to treat surgical patients for hyperglycemia and what target BG to achieve, the surgeon must take into account the patient's clinical status, because the evidence has shown optimal benefit at different levels.
- In critically ill and noncritically ill surgical patients, insulin therapy should be used with a goal BG of 140 to 180 mg/dL.

INTRODUCTION

Hyperglycemia is a common finding in patients undergoing surgery. Up to 40% of noncardiac surgery patients have a postoperative level of blood glucose (BG) greater than 140 mg/dL, with 25% of those patients having a level greater than 180 mg/dL.[1] Perioperative hyperglycemia has been associated with increased morbidity, decreased survival, and increased resource utilization.[2–4] For example, McConnell and researchers[5] found a mean 48-hour postoperative glucose greater than

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200 mg/dL in patients after colorectal surgery was associated with an increased incidence of surgical site infection. Similar associations have been found in patients following total joint arthroplasty, infra-inguinal vascular surgery, orthopedic spinal surgery, hepato-biliary-pancreatic surgery, and mastectomy.[6–10] As a treatable and therefore preventable complication, optimal perioperative glycemic control is quickly becoming standard of care.

Evidence suggesting hyperglycemia is a modifiable and independent predictor of adverse outcomes in surgical patients led to widespread implementation of intensive insulin therapy (IIT) with perioperative BG targets of 80 to 110 mg/dL. However, further investigation into the use of IIT failed to show a survival benefit, leading researchers to question what constitutes "normoglycemia" in the perioperative period. The purpose of this review is to summarize the pertinent research on perioperative glucose management, evaluate the pathophysiology of glucose control and glycemic disturbances, discuss the workup and assessment of preoperative patients, and analyze optimal management strategies.

NATURE OF THE PROBLEM

Hyperglycemia in the critically ill was once viewed as a normal adaptive response to the stress placed on the body by disease. Insulin resistance was thought to be causative factor, because it has been demonstrated in greater than 80% of all critically ill patients.[11] Additional research showed that hyperglycemia is the clinical endpoint of multiple physiologic processes, including increased cortisol, catecholamines, glucagon, growth hormone, gluconeogenesis, and glycogenolysis.[12] Once viewed as an adaptive response essential for survival, hyperglycemia was not routinely monitored or controlled in the perioperative patient.

In the late 1980s, researchers discovered improved cardiac function with glucose-insulin-potassium (GIK) infusion for 48 hours after coronary artery bypass grafting.[13] GIK was found to be safe and effective in the treatment of refractory left ventricular failure after grafting. Early studies involving GIK emphasized the importance of glucose and insulin in surgical patients, but offered little insight to glycemic control. The beneficial effect of GIK on cardiac function was likely due to the metabolic effects of insulin, including the ability to promote the use of glucose as a primary myocardial energy substrate. However, these effects were unrelated to glycemic control because BG was not corrected or controlled.

The adverse outcomes of individuals with diabetes were established in the early 1990s and were thought to be secondary to the direct effect of hyperglycemia on immune function, pathogen growth, and vascular permeability, and the indirect effect via the long-term consequences of hyperglycemia on the microvascular system.[14,15] In critically ill patients in the intensive care unit (ICU), levels of BG greater than 180 mg/dL are associated with impaired neutrophil function, increased infection risk, longer hospital stays, and increased mortality.[3] Further studies showed that IIT with intravenous (IV) insulin to a level of target glucose less than 150 mg/dL reduced the incidence of myocardial infarction (MI) and cerebrovascular accidents (CVA) in diabetics with known atherosclerosis. MI and CVA constituted most of the postoperative complications in diabetics. Therefore, researchers proposed that better glycemic control may improve other perioperative complications in patients with diabetes. Early studies focused on perioperative glycemic control and the risk of infectious complications after coronary artery bypass surgery. Researchers showed that postoperative hyperglycemia is an independent predictor of short-term infectious complications and recommended a glucose target level of less than 200 mg/dL to reduce the risk of infection.[16]