Q: Does unrecognized diabetes in the preoperative period worsen postoperative outcomes?

KRISTA ANDERSEN-HARRIS, DO
Department of Hospital Medicine,
Cleveland Clinic, Cleveland, OH

CHRISTOPHER WHINNEY, MD
Department of Hospital Medicine,
Cleveland Clinic, Cleveland, OH

A: Yes. Studies in both cardiac and noncardiac surgical patients demonstrate a correlation between glucose levels and length of hospital stay, in-hospital mortality, wound healing and infection rates, length of stay in the intensive care unit (ICU), and health care utilization. Randomized controlled trials in cardiac surgery patients and in surgical ICU settings demonstrate improved outcomes with aggressive glycemic control.

Surgery and hyperglycemia

Approximately 15% to 20% of patients who undergo surgery in the United States have diabetes, and this proportion is likely higher among those undergoing cardiothoracic procedures.[1] Many more patients proceed to surgery with undiagnosed diabetes, which is usually untreated.

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Much of our current practice is based on the limited number of available studies and our knowledge of complications that result from hyperglycemia. Euglycemia is maintained by a strict balance between insulin and counterregulatory hormones such as cortisol, catecholamines, glucagon, and growth hormone. The stress of surgery and anesthesia disrupts this balance and increases levels of these counterregulatory hormones. Hepatic glucose production and peripheral insulin resistance increase, while glucose uptake and utilization in peripheral tissues and insulin secretion decrease. The decreased levels of insulin and elevated levels of catecholamines and glucagon stimulate protein catabolism and lipolysis, providing the precursors needed for gluconeogenesis, ultimately leading to hyperglycemia.

Hyperglycemia and poor surgical outcomes

Hyperglycemia has been associated with a host of complications, including dehydration, electrolyte abnormalities, impaired wound healing, diabetic ketoacido-

sis, and nonketotic hyperosmolar coma. Elevated glucose levels correlate with increased morbidity and mortality in both cardiac and noncardiac surgical patients, and a number of studies have shown that aggressive glycemic control improves clinical outcomes.

Cardiac surgery. Several studies have evaluated postoperative complications among diabetic patients undergoing coronary artery bypass graft (CABG) surgery. Golden et al noted progressively higher rates of infectious complications (including sternal and leg wound infections, pneumonia, and urinary tract infections) among patients with higher blood glucose levels in the 36 hours following surgery.[2] Researchers at Providence St. Vincent Medical Center in Portland, Oregon, have published several studies evaluating glycemic control and outcomes in patients undergoing CABG surgery.[3–5] In 1991 they implemented an aggressive insulin infusion protocol aimed at maintaining blood glucose levels below 200 mg/dL, with resultant decreases in the risk of deep sternal wound infections, length of hospital stay, and overall in-hospital mortality.[3–5]

Surgical ICU. Intensive treatment of hyperglycemia has also been evaluated in the surgical ICU setting in a randomized controlled trial from Belgium.[6] This study showed that aggressive insulin therapy aimed at maintaining blood glucose levels of 110 mg/dL or less was associated with reductions in both ICU and in-hospital mortality, ICU length of stay, bacteremia, duration of antibiotic use, acute renal failure, and the need for mechanical ventilation.

Noncardiac surgery. A recent retrospective case-control study from the Netherlands compared 904 patients who died within 30 days of hospitalization for noncardiac, nonvascular surgery with 1,247 matched controls.[7] Patients with preoperative glucose levels of 200 mg/dL or greater had twice the overall mortality rate and a fourfold higher rate of cardiovascular mortality compared with controls. "Prediabetes" glucose levels (110 to 200 mg/dL) were found to have a similar but less pronounced association with increased mortality. The authors suggested that impaired glucose tolerance may be a risk factor for perioperative cardiac events, as the pathophysiologic changes in the vasculature may be under way before the onset of outright diabetes.

Studies of intensive glucose control have not yet been performed in patients undergoing noncardiac, nonvascular surgery, so it is not known whether aggressive control in this patient population will lead to benefits similar to those in the cardiac surgery and surgical ICU settings.

Unrecognized diabetes: A common cause of complications

In a retrospective analysis of 2,030 patients admitted to a single community hospital, Umpierrez et al found that 37% of patients admitted for surgery had hyperglycemia that was previously unrecognized.[8] Among all patients with newly discovered hyperglycemia, in-hospital mortality was 16%, compared with 1.7% among patients with normoglycemia. Patients with newly discovered hyperglycemia also had worse functional outcomes and longer hospital stays, and were more frequently admitted to the ICU and more likely to need skilled care or nursing home care at discharge.

Conclusions

Patients with hyperglycemia undergo surgery frequently and are at increased risk of perioperative complications, regardless of whether they carry a prior diagnosis of diabetes. Current evidence suggests that optimal treatment of hyperglycemia, with a target blood glucose level of 110 mg/dL or less, reduces the risk of perioperative complications and death.[9] Further studies are needed to ascertain the ideal blood glucose level for minimizing complications and to better define patient populations that will benefit from aggressive glycemic control measures.

REFERENCES

1. **Clement S, Braithwaite SS, Magee MF, et al.** Management of diabetes and hyperglycemia in hospitals. Diabetes Care 2004; 27:553–591.
2. **Golden SH, Peart-Vigilance C, Kao WHL, Brancati FL.** Perioperative glycemic control and the risk of infectious complications in a cohort of adults with diabetes. Diabetes Care 1999; 22:1408–1414.
3. **Zerr KJ, Furnary AP, Grunkemeier GL, Bookin S, Kanhere V, Starr A.** Glucose control lowers the risk of wound infection in diabetics after open heart operations. Ann Thorac Surg 1997; 63:356–361.
4. **Furnary AP, Zerr KJ, Grunkemeier GL, Starr A.** Continuous intravenous insulin infusion reduces the incidence of deep sternal wound infection in diabetic patients after cardiac surgical procedures. Ann Thorac Surg 1999; 67:352–360.
5. **Furnary AP, Chaugle H, Zerr KJ, Grunkemeier GL.** Postoperative hyperglycemia prolongs length of stay in diabetic CABG patients [abstract]. Circulation 2000; 102(Suppl II):II-556. Abstract 2703.
6. **van den Berghe G, Wouters P, Weekers F, et al.** Intensive insulin therapy in critically ill patients. N Engl J Med 2001; 345:1359–1367.
7. **Noordzij PG, Boersma E, Schreiner F, et al.** Increased preoperative glucose levels are associated with perioperative mortality in patients undergoing noncardiac, nonvascular surgery. Eur J Endocrinol 2007; 156:137–142.
8. **Umpierrez GE, Isaacs SD, Bazargan N, You X, Thaler LM, Kitabchi AE.** Hyperglycemia: an independent marker of in-hospital mortality in patients with undiagnosed diabetes. J Clin Endocrinol Metab 2002; 87:978–982.
9. **Hoogwerf BJ.** Perioperative management of diabetes mellitus: how should we act on the limited evidence? Cleve Clin J Med 2006; 73(Suppl 1):S95–S99.

Correspondence: *Krista Andersen-Harris, DO, Department of Hospital Medicine, Cleveland Clinic, 9500 Euclid Avenue, S70, Cleveland, OH 44195; andersk@ccf.org.*