Glucose control reduces infection risk

Patients’ blood glucose levels can climb under the stress of cardiac surgery, making them more vulnerable to infection and other complications.

When one hospital began monitoring blood glucose levels, it found almost all patients having open-heart surgery with cardiopulmonary bypass—90%—had a blood glucose level above 200 mg/dL at some point during the perioperative period.

Another interesting finding—10% of the patients had previously undiagnosed diabetes.

“We have identified a lot of diabetics who previously didn’t know they were diabetic,” notes the hospital’s director of cardiac surgical research, Richard Engelman, MD, a retired cardiac surgeon.

A national project

Baystate Medical Center in Springfield, Mass, began a project in 2002 to measure and manage hyperglycemia in its cardiac surgical patients. The 600-bed hospital, which performs about 850 heart operations a year, represented Massachusetts in the national Surgical Infection Prevention (SIP) collaborative sponsored by the Centers for Medicare and Medicaid Services.

In the year-long collaborative, which wrapped up in 2003, some organizations have seen infection rates drop by as much as 70% to 100% for target procedures. The project is now being carried forward by state level Quality Improvement Organizations (QIOs).

Baystate’s cardiac surgery infection rate in the last quarter of 2003 “was the lowest it has ever been,” notes Dr Engelman. He attributes the results at least in part to tighter glucose control and other SIP initiatives, which include improving use of prophylactic antibiotics, warming patients, and eliminating the preoperative shave by using clippers instead.

The Baystate team took on the project because of some compelling evidence. Dr Engelman says, “There is very hard data both from clinical services and research laboratories indicating that having elevated blood sugars has adverse consequences for patients having cardiac surgery.”

There is some debate about whether blood glucose should be maintained below 200 mg/dL, 150 mg/dL, or perhaps even 120 mg/dL.

“Clearly, having blood sugars greater than 200 is associated with changes at the cellular level,” Dr Engelman says. Glucose can attach to the cell wall and make the cell membrane more permeable to fluid and bacteria, which are associated with higher rates of infection and other complications.

He referred to a 2001 study in the New England Journal of Medicine of 1,500 patients in the surgical ICU, who were randomly assigned to receive intensive insulin therapy (control of blood sugar levels under 110 mg/dL) or conventional therapy. The intensive therapy reduced mortality from 8% to 4.6% and lowered bloodstream infections, acute renal failure, and other complications. Closely controlled patients were also less likely to need prolonged mechanical ventilation and intensive care.

“No one had ever shown that before, and it made quite a hit in terms of understanding the ramifications of elevated blood sugar,” Dr Engelman notes.

Not everyone agrees such strict control is necessary, but the study documented the difference such a rigorous effort could make.

The body’s stress response

Blood sugars are elevated during surgery for several reasons, he explains.

First, the body’s stress response leads to release of epinephrine, which in turn induces hyperglycemia. Also, drugs administered during the procedure, includ-
ing epinephrine, can raise blood sugar levels, and the cardioplegia solution contains glucose, which further contributes to hyperglycemia.

Baystate’s project was guided by a quality improvement team in consultation with the Department of Endocrinology. On the team were Dr Engelman and representatives from the quality division, nursing, OR personnel, anesthesia providers, and the pharmacy.

**Baystate’s protocol**

In brief, the protocol outlines these steps:

- A fasting blood glucose level is measured in the preoperative holding area for every patient coming to the OR for open-heart surgery.
- For the 30% of patients who have a history of diabetes and a fasting blood glucose of > 75 mg/dL, a protocol is automatically instituted for IV insulin administration during surgery.
- For the remaining 70% of patients, blood glucose is monitored every hour in the OR by the anesthesiologist, using point-of-care testing. An IV insulin drip is initiated if the blood glucose is > 150 mg/dL, starting at the rate of 3 units/h and increasing to as much as 10 to 15 units/h for some patients. Of this group, about 30% will have a prediabetic condition known as fasting-impaired blood glucose (FIBG), with fasting blood glucose levels of 110 mg/dL to 126 mg/dL, and 10% to 15% will have previously undiagnosed diabetes. Their primary care physicians are notified of their condition before they are discharged from the hospital to ensure follow-up.
- Blood glucose measurement and management continue in the cardiac ICU by RNs in consultation with physicians. A conversion protocol is being developed for a smooth transition from IV insulin to subcutaneous or oral administration. This is challenging because of the number of patients who are resistant to insulin.

Nurses on regular patient units are sometimes reluctant to give patients IV insulin because of the time it takes to monitor patients and concerns about hypoglycemia. But Dr Engelman notes that in Baystate’s experience, patients who receive insulin in a continuous IV infusion are less likely to have large swings in their blood glucose level because they are on a steady dose. They are more likely to become hypoglycemic if they receive bolus injections.

**Managing blood glucose in the OR**

In the OR, blood glucose control is managed by the anesthesiologists.

“Initially, they were concerned that this was not their responsibility,” Dr Engelman acknowledges.

Once the project team explained the evidence supporting glycemic control, the anesthesiologists were willing to manage the infusion, he says. Gary Kanter, MD, of the cardiac anesthesia staff became the clinical champion for the Department of Anesthesiology.

“This really is not such a difficult thing in organizations doing a lot of cardiac surgery because usually there are anesthesiologists who are interested in improving quality. It is something they will accept once they see the data,” Dr Engelman says.

Glucose control is tracked by Bay-state’s Division of Health Care Quality, and the project team meets monthly to review results to see if they are within limits or if the protocol needs to be modified.

Currently, a little over 50% of target patients are being maintained at < 150 mg/dL in the first 48 hours after the procedure, and 75% to 80% are maintained at < 200 mg/dL.

“You have to recognize that if you are recording every blood sugar, a patient may suddenly go out of range for one measurement. Then you get dinged for not meeting the goal, but you still are managing the patient’s blood sugar. So I think we are going to be happier with trend analysis than looking at any one number,” he adds.
Should blood glucose levels be controlled for other surgical procedures as well?

Considering the complications that can ensue with hyperglycemia, “I think there probably is a real risk in the noncardiac-surgery population,” he comments. In addition, a large number of elderly patients are hyperglycemic.

He cited as at “major league risk” patients who are having procedures such as abdominal aortic aneurysm repair, major vascular surgery, and major cancer resections.

—Pat Patterson

Aims of glucose control

Glucose control was an optional intervention in the national Surgical Infection Prevention project.

For participants, the aims were to:

- maintain serum glucose at < 200 mg/dL in cardiac surgery patients for 48 hours after the procedure
- reduce by 50% the number of patients who do not have perioperative glucose control during the first 48 hours after surgery.

Studies on glucose control

High blood glucose levels were associated with longer hospital stays and increased charges of about $2,800 and increased costs of about $1,800 in patients having coronary artery bypass graft surgery.


Intensive insulin therapy to maintain blood glucose at or below 110 mg/dL reduces morbidity and mortality among critically ill patients in the surgical ICU.


Postoperative hyperglycemia and previously undiagnosed diabetes were associated with development of surgical site infections in cardiothoracic surgery patients.


Patients with hyperglycemia, particularly mean glucose levels of 200 mg/dL to 230 mg/dL within 36 hours following coronary artery surgery, were more likely to develop infections than patients whose glucose was better controlled.


Continuous IV insulin infusion to control blood glucose levels during cardiac surgery significantly reduced the incidence of deep sternal wound infections.


Articles on preventing surgical infection

Previous articles in this series about the national Surgical Infection Project include:


Keeping patients warmed. April 2004 OR Manager, p 1, 12-13, 15

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