

# Pre-Surgical Evaluation of Diabetic Patients

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In the general population, there are numerous indications for surgery, such as cardiac, vascular, abdominal, and orthopedic problems. People with diabetes may also face surgery for these common problems, as well as for procedures prompted by the long-term complications of their disease.

This high-risk group will undergo cardiovascular and ophthalmological procedures at a greater rate than will their nondiabetic peers. They may also require a transplant associated with diabetes, such as a kidney transplant in the setting of renal failure or a pancreas transplant. Furthermore, diabetic complications may require penile prosthesis implantation, ulcer debridement, or limb amputation.<sup>1</sup> During the postoperative period, diabetic patients face poor wound healing, increased incidence of acute renal failure, and increased infection rates.

When diabetic patients enter the surgical arena, they face several challenges that are not present in nondiabetic patients. Many of the problems arise because diabetic patients are not able to maintain a balance between insulin and its counterregulatory hormones.

On one side of the equation, insulin acts as the primary anabolic hormone that promotes glucose uptake by the muscle and fat cells while decreasing glucose production by the liver. This occurs because insulin suppresses gluconeogenesis and glycogenolysis. The net effect is to lower blood glucose levels.

The counterregulatory hormones, including epinephrine, glucagon, cortisol, and growth hormone, have the opposite effect. They raise blood glucose by stimulating glycogenolysis and gluconeogenesis in the liver; by increas-

ing lipolysis and ketogenesis; and by inhibiting glucose utilization by muscle and fat.

Surgery and anesthesia provoke a neuroendocrine stress response, which releases these counterregulatory hormones and causes hyperglycemia and increased catabolism. The magnitude of the response depends on the severity of surgery and on complications such as sepsis, hypotension, hypovolemia, and acidosis.<sup>1</sup>

Nondiabetic patients can increase insulin secretion and maintain glucose homeostasis throughout a surgical procedure. Diabetic patients are unable to compensate, which results in hyperglycemia. People with type 1 diabetes will be susceptible to diabetic ketoacidosis (DKA). Those with type 2 diabetes will be susceptible to hyperglycemic hyperosmolar nonketotic syndrome (HHNK) and may also be susceptible to DKA if they have very poor metabolic control.

## Avoiding Hyperglycemia Is Important

Hyperglycemia has many other adverse effects. It can impair wound healing by hindering collagen production, resulting in decreased tensile strength of surgical wounds. Hyperglycemia can increase infection because glucose levels above 250 mg/dl are thought to impair leukocyte chemotaxis and phagocytosis.<sup>2</sup>

Other effects include an increase in plasminogen activator factor inhibitor and abnormal platelet function resulting in abnormal coagulation. Finally, hyperglycemia may exacerbate ischemic brain damage in the elderly.<sup>2</sup>

Every effort should be made to minimize these problems by controlling patients' diabetes as well as possible

starting several weeks before scheduled surgery.

## Presurgical Evaluation

Physicians and patients can take several practical steps to help minimize problems during surgery and in the postoperative period.

Before surgery, a physical exam should be performed and a complete diabetic history taken to prepare the anesthesiologist and surgeon. Clinicians should provide anesthesiologists with details regarding patients' current level of metabolic control and diabetic complications, including renal function, heart disease, presence of autonomic neuropathy, and any history of DKA or HHNK.

Evaluation of metabolic control should begin with an examination of patients' blood glucose logbooks and HbA<sub>1c</sub> or fructosamine results. Logbooks should be examined for episodes of hypoglycemia and extreme hyperglycemia.

Patients' pharmacological regimen, dosages, and timing of medication ingestion should be examined. This will aid in making recommendations about withdrawal of medication before the perisurgical period, when patients will be fasting.

Patients' usual dietary intake, including carbohydrate content and timing of meals, should also be noted. This is especially important in the postoperative period because patients who have had a high caloric intake may have required large doses of oral medication or insulin. If such patients have a prolonged postoperative recovery period during which they are fasting or eating very little, they may have a decreased medication requirement

or be prone to hypoglycemia.

Patients' usual physical activity level before surgery is also an important factor. High levels of physical activity may have significantly lowered patients' diabetic medication requirements. During a period of recovery and decreased mobility, such patients' medication requirements may increase dramatically.

**Preoperative Evaluation of the Cardiovascular System**

In the diabetic population, particular emphasis should be given to the cardiovascular system.

In the general population, a history of recent myocardial infarction (MI) is a clinical predictor for increased risk of a perioperative cardiac event. A patient has a 6% rate of reinfarction or death if surgery is performed within 3 months of an MI. The rate falls to a 2% chance of reinfarction or death if surgery is performed within 6 months, and the rate further decreases to 1.5% if surgery is performed more than 6 months after the MI.<sup>3,4</sup> These statistics also apply to the diabetic population. Therefore, elective surgery for diabetic patients should be delayed after a cardiac event, if possible.

Because diabetic patients frequently have underlying hypercholesterolemia, macrovascular disease, and neuropathy, the probability of underlying silent ischemia is increased. Therefore, the preoperative work-up should begin with a resting echocardiogram (EKG) on all patients. There should be a low threshold for stress testing if the resting EKG shows evidence of ischemia or a patient's history is suggestive of coronary artery disease. If indicated, cardiac consultation should be obtained for more sensitive diagnostic tests and procedures before surgery.

The Goldman Cardiac Risk Index<sup>4</sup> (Table 1) was one of the first widely accepted models to assess patients' cardiac risk factors. This index took into consideration patients' cardiac risk factors as well as their general medical condition. It weighted several variables and assigned them a score. A higher score

indicates a higher predicted risk. These scores were then totaled, and patients were placed into one of four classes, ranging from low risk (Class 1) to high risk (Class 4). Significantly, angina was not included in this model.<sup>5</sup>

The original Goldman Index retains value in preoperative assessment. Refinements have been made to simplify the original model. The Modified Goldman<sup>6</sup> was revised to include type of surgery, history of ischemic heart disease, history of heart failure, history of cerebral vascular disease, preoperative treatment with insulin, and preoperative serum creatinine >2.0 mg/dl.

These cardiac risk indexes help to predict high postoperative risk (Class 3 and Class 4 patients). However, there are still a significant number of adverse postoperative events in Class 1 and Class 2 patients. The Eagle Risk Index<sup>7</sup> was developed to address this concern. This model also specifically includes diabetes as a risk factor.

The Eagle Index identifies five clinical predictors: Q waves, history of ventricular ectopic activity, diabetes, advanced age, and angina. The absence

of these risk factors helps to identify patients at lower risk of cardiac events.

**Additional Preoperative Evaluations**

Renal function is another common diabetic complication that should be evaluated, especially if a dye study is planned or reduced cardiac output is anticipated. Unfortunately, the most common test, serum creatinine, may not be a reliable indicator.

The first step in the renal work-up is to screen for microalbuminuria. If this is positive, order a 24-h urine collection to determine creatinine clearance.

Patients with a compromised creatinine clearance are at increased risk of renal failure. These patients should avoid contrast materials and nephrotoxic agents. Careful monitoring should be instituted for both pre- and postoperative periods.

Blood pressure should be checked and hypertension should be controlled before surgery. Hypertension is not a contraindication to surgery if it is well controlled to at least 140/90 mmHg.

Diabetic autonomic neuropathy predisposes patients to perioperative

**Table 1. Goldman Cardiac Risk Index<sup>4</sup>: Nine Independent Risk Factors That Correlated to Perioperative Fatal or Major Nonfatal Events**

1. Age over 70 years—5 points
2. MI in the previous 6 months—10 points
3. S3 gallop or jugular venous distension—11 points
4. Important aortic stenosis—3 points
5. Rhythm other than sinus or premature atrial contractions on last preoperative EKG—7 points
6. >5 premature ventricular contractions per minute documented at any time before operation—7 points
7. PO<sub>2</sub> <60 or PCO<sub>2</sub> >50 mmHg; K<3.0 or HCO<sub>3</sub> <20 mEq/L; BUN >50 or Cr >3.0 mg/dl; abnormal AST, signs of chronic liver disease, or bedridden from noncardiac causes.
8. Intraperitoneal, intrathoracic, or aortic operation—3 points
9. Emergency operation—4 points

Risk:

- Class 4: High risk: ≥26 points
- Class 3: Intermediate to high risk: 13–25 points
- Class 2: Low to intermediate risk: 6–12 points
- Class 1: Low risk: 0–5 points

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hypotension. Symptoms include dizziness, lightheadedness, dimming of vision on standing, and syncope. Signs include a drop in systolic blood pressure >30 mmHg upon standing. Diagnostic tests include orthostatic blood pressure measurements. Patients with orthostatic hypotension require careful monitoring of blood pressure and volume status, or additional medication to treat this disorder.<sup>1</sup>

A history of impaired gastric emptying indicates the presence of diabetic gastroparesis. This can put a patient at risk for aspiration. In addition, postoperative resumption of oral nutrition may be difficult.

Routine preoperative labs should include a chemistry panel, complete blood counts, thrombin and prothrombin times, liver function tests, and a pregnancy test for women of childbearing potential.

There is significant controversy regarding the need for routine preoperative chest X-rays. Certainly, patients with known underlying pulmonary disease or risk factors such as smoking should have routine chest X-rays before surgery.

### Adjusting Diabetes Medications for Surgery

If possible, admit patients with diabetes 1 day before surgery to maximize their metabolic control and correct any electrolyte imbalances.

A common question regarding preoperative management involves timing the discontinuation of oral diabetes medications and insulin. Newer generation sulfonylureas, such as glyburide (Micronase) and glipizide (Glucotrol), can be withheld the morning of the surgery. Metformin (Glucophage) should be stopped 24 h before the procedure. This is done to prevent the possibility of lactic acidosis if the patient's renal function is compromised because of the surgery or its complications. The thiazolidinedione insulin sensitizers (rosiglitazone [Avandia] and pioglitazone [Actos]) can be stopped the morning of the procedure.

Alpha-glucosidase inhibitors acarbose (Precose) and miglitol (Glyset) can be held the morning of the surgery.

Consider stopping long-acting insulin (human ultralente) 1 day before surgery, and stabilize the patient on a regimen of NPH and regular insulin. This regimen should be customized for each patient depending on metabolic control, timing, and the duration of the surgery. Table 2 offers some general guidelines. Measure plasma glucose,

electrolytes, and urinary ketones on the day of surgery.

Diabetic patients should be first on the day's surgical schedule so that they are not NPO for long periods of time before the start of their surgical procedures. Care should be taken in the event of a delayed or afternoon surgery to monitor patients' blood glucose to prevent hypoglycemia or severe hyperglycemia. Patients should never undergo anesthesia without a blood glucose

**Table 2. General Guidelines for Diabetic Patients on the Day of Surgery\***

For obese patients with type 2 diabetes controlled by diet alone:

1. For short, elective procedures, therapy may not be needed.
2. Always check blood glucose levels before surgery.
3. If blood glucose is:
  - <70 mg/dl, give 100–200 cc of 5 or 10% dextrose solution.
  - 70–250 mg/dl, give regular fluids (D5 1/2 normal saline solution to keep vein open)
  - 250–300 mg/dl, give 4–6 U of regular human insulin subcutaneously.
  - 301–350 mg/dl, give 6–8 U of regular human insulin subcutaneously.
  - >350 mg/dl, consider canceling surgery or consider using an insulin drip to correct the glucose values.

For type 2 diabetic patients on oral hypoglycemic agents only:

1. Do not stop medication for short procedures unless you expect prolonged illness or NPO status. The exception is metformin, which should be stopped 24 hours before surgery.
2. For longer surgeries, stop thiazolidinediones, oral sulfonylureas, and alpha-glucosidase inhibitors the morning of surgery.
3. Check blood glucose levels before surgery.
4. Use the sliding scale listed above for patients with diet-controlled type 2 diabetes.

For type 1 or type 2 diabetic patients on insulin therapy (normally a split/mixed regimen):

1. Check blood glucose levels before surgery and use the following guidelines:

<b>Presurgical blood glucose</b>	<b>Intermediate-acting insulin (% of patient's usual insulin dose)</b>	<b>Regular insulin</b>
70–150 mg/dl	50	none
151–250 mg/dl	67	3–4 U
251–350 mg/dl	75	5–8 U
>350 mg/dl	Consider canceling surgery or consider using an insulin drip to correct the glucose values.	

\*In general, obese patients will need more insulin than thin patients. Check blood glucose levels immediately after surgery and then hourly until the patient is stable. These are general guidelines; every diabetic patient is different.

determination before the anesthetic is started.

During surgical procedures for diabetic patients, surgeons and anesthesiologists should monitor patients' blood glucose hourly. In type 1 diabetic patients, an insulin drip is often started for long procedures. In patients with well-controlled type 2 diabetes, hourly fingersticks can be performed and subcutaneous insulin or an insulin drip can be started if blood glucose levels become problematic during the procedure.

### Postoperative Preparation

In addition to the preoperative work-up, a few practical measures can facilitate a smooth postoperative period. Patients undergoing orthopedic procedures can apply in advance for a temporary disabled parking permit. For patients whose eating status is expected to be variable after surgery, a postoperative sliding scale insulin action plan and sick-day rules can be discussed in advance. Physicians can write and patients can fill prescriptions well in advance of surgery for pain and anti-nausea medications that may be needed in the postoperative period. Patients always greatly appreciate these steps.

### Summary

People with diabetes present unique challenges for surgery because of their delicate metabolic balance between insulin and its counterregulatory hormones. The complications related to diabetes present further challenges, especially with regard to cardiac risk assessment.

A medical history and physical examination, application of the cardiac risk indexes, and the appropriate ancillary tests will help to risk-stratify patients.

Diabetes must be controlled tightly preoperatively. This will improve coagulation and wound healing and decrease the chance of postoperative infections. Careful preoperative assessment and planning by clinicians can help diabetic patients endure the difficult surgical period.

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