

# DIABETES AND SURGERY

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# Introduction



Careful assessment of patients with diabetes prior to surgery is required because of their complexity and high risk of coronary heart disease.



Diabetes mellitus is also associated with increased risk of perioperative infection and postoperative cardiovascular morbidity and mortality.

**Pre-operative  
management of  
diabetic patient  
include :**



1- glycemic control.



2- review of medications .



3- anesthesia.



4- identify high risk patients requiring critical care management.



5- consider the presence of complications of diabetes that might adversely affect or that might adversely impact upon the outcome of the proposed procedure .

# Effects of surgery on glucose control

Surgery and general anesthesia cause a neuroendocrine stress response with release of counter regulatory hormones, such as *epinephrine*, *glucagon*, *cortisol*, and *growth hormone*, and of *inflammatory cytokines*, such as interleukin-6 and tumor necrosis factor-alpha. These neurohormonal changes result in metabolic abnormalities including insulin resistance, decreased peripheral glucose utilization, impaired insulin secretion, increased lipolysis, and protein catabolism, leading to hyperglycemia .

# Cont....

\*Magnitude of counter regulatory hormone release varies per individual and is influenced by:

- the type of anesthesia (general anesthesia is associated with larger metabolic abnormalities as compared with epidural anesthesia).
- the extent of the surgery (cardiovascular bypass surgery resulting in significantly higher degree of insulin resistance).
- additional postoperative factors such as sepsis, and glucocorticoid use.

# Pre-operative evaluation:

- 1- *Cardiopulmonary risk assessment and modification.*
- 2- Hypertension.
- 3- Obesity.
- 4- chronic kidney diseases .
- 5- cerebrovascular disease .
- 6- Autonomic neuropathy.

# Cont...

All diabetic patients require a careful history and physical examination . Key elements of the initial assessment include the following :

- 1) Determination of the **type of diabetes**, since type 1 diabetes patients are at much higher risk of diabetic ketoacidosis and must have basal insulin supplied at all times.
- 2) **Long-term complications** of diabetes mellitus, including retinopathy, nephropathy, neuropathy, autonomic neuropathy, coronary heart disease, peripheral vascular disease, and hypertension.
- 3) Assessment of **baseline glycemic control**, including frequency of monitoring, average blood glucose levels, range of blood glucose levels, and glycated hemoglobin (A<sub>1</sub>C) levels

# Cont...

- 4) Assessment of **hypoglycemia**, including frequency, timing, awareness, and severity.
- 5) Detailed **history of diabetes therapy**.
- 6) Other **pharmacologic therapy**, including type of medication.
- 7) **Characteristics of surgery**, including when the patient must stop eating prior to surgery, type of surgery (major or minor), timing of the operative procedure, and duration of the procedure.
- 8) **Type of anesthetic**, including epidural or regional versus general anesthesia .

# Laboratory evaluation:

- **ECG.**
- **Renal function .**
- **HBA<sub>1</sub>C.**
- **Blood glucose.**

# Goals of glycemic control:

- ❑ Avoidance of hypoglycemia
- ❑ Prevention of ketoacidosis/hyperosmolar states
- ❑ Maintenance of fluid and electrolyte balance
- ❑ Avoidance of marked hyperglycemia

## Cont...

**Hypoglycemia** is a potentially life-threatening complication of poor perioperative metabolic control. **Severe** hypoglycemia (ie, serum glucose concentration  $<40 \text{ mg/dL}$  [2.2 mmol/L]), even for short periods of time, can induce arrhythmias, or transient cognitive deficits.

Hypoglycemia and subsequent neuroglucopenia can be difficult to detect in sedated or anesthetized patient.

# Cont...

**Hyperglycemia** may lead to :

- 1) There is association between preoperative hyperglycemia and postoperative infections .
- 2) can cause volume and electrolyte disturbances .
- 3) Hyperglycemia may result in protein loss in underinsulinized patient .

# Glycemic target :

Diabetes guideline bodies recommend glycemic targets of **between 110 and 180 mg/dL** for noncritically ill hospitalized patients.

However, a less stringent glucose target (<200 mg/dL ) may be considered depending on risk for hypoglycemia and also potentially in the general patient population.

# Perioperative phase :

*Type 2 diabetes treated with diet alone* : Patients with type 2 diabetes managed by diet alone do not require any therapy perioperatively.

Blood glucose levels should be checked **preoperatively** and **soon after the surgery**. For long surgeries (more than two hours) or surgeries associated with expected high glucose levels (eg, coronary artery bypass grafting, organ transplants with steroid use) .

**Intraoperative** glucose testing every one to two hours should be performed either by laboratory or point of care testing (using a blood glucose meter.

Intravenous (IV) solutions do not require dextrose if insulin is not given.

## Cont...

### Type 2 diabetes treated with oral hypoglycemic agents/noninsulin injectables :

- Patients with type 2 diabetes who take oral hypoglycemic drugs or noninsulin injectables (eg, glucagon-like peptide-1 [GLP-1] analogs) are advised to continue their usual routine of antidiabetic medications until the morning of surgery. On the morning of surgery, they should hold their oral hypoglycemic and noninsulin injectable drugs.

# Medications:

- **Sulfonylureas** increase the risk of hypoglycemia.
- **Metformin** is contraindicated in conditions that increase the risk of hypoperfusion, lactate accumulation, and tissue hypoxia.
- **Thiazolidinediones** may worsen fluid retention and peripheral edema and could precipitate congestive heart failure.
- **Sodium-glucose cotransporter 2 (SGLT2) inhibitors** increase the risk of hypovolemia. There have also been reports of acute kidney injury and euglycemic diabetic ketoacidosis in patients with type 2 diabetes taking SGLT2 inhibitors.
- **Other agents like dipeptidyl peptidase-4(DPP-4) inhibitors and GLP-1 analogs** could alter gastrointestinal (GI) motility and worsen the postoperative state.

# Monitoring:

- Most patients with good glycemic control (glycated hemoglobin [A<sub>1</sub>C] <7.0 percent ) on oral or noninsulin injectable agents will not need insulin for short surgical procedures.
- Capillary "fingerstick" blood glucose should be monitored every two hours, using a blood glucose meter.
- For patients who develop hyperglycemia, supplemental short- or rapid-acting insulin may be administered subcutaneously (typically every six hours), based on frequently (every one to two hours) measured glucose levels which are often obtained on capillary "fingerstick" samples.
- In patients who are critically ill, are on vasopressor agents, or hypotensive, venous or arterial blood and laboratory testing should be used instead of fingerstick samples and a blood glucose meter.



**Type 1 insulin-treated**

# (Short procedures)

- ❖ patients who use insulin **can continue** with subcutaneous insulin perioperatively (rather than an insulin infusion) for procedures that are not long and complex (eg, less than two hours)
- ❖ For minor, early morning procedures where breakfast is likely only delayed, patients may delay taking their usual morning (short- or rapid acting insulin) insulin until after the surgery and before eating.

- patients who take once-daily, long-acting or basal insulin (eg, glargine, degludec) or who use continuous insulin infusion (insulin pump) :

may continue basal insulin without any change to their usual regimen, as long as the basal insulin dose has been correctly calculated. In patients whose basal rate is calculated to keep the blood glucose in normal or low-normal ranges or when there is history of low glucose measures as an outpatient, we often reduce the dose (or rate) by 10 to 25 percent to avoid any chance of preoperative hypoglycemia.

- ❑ For patients undergoing morning procedures where breakfast and possibly lunch are likely to be missed ,or for surgeries that take place later in the day:

**Skip** any short-acting or rapid-acting (eg, lispro, aspart, glulisine) insulin on the morning of surgery

- ❑ For patients who take two types of insulin (intermediate or long and rapid or short-acting) only in the morning:

**Give** between one half to two-thirds of their usual total morning insulin dose (both types of insulin) to provide basal insulin during the procedure and prevent ketosis.

- ❑ For patients who take insulin (intermediate or long and rapid or short-acting) two or more times per day:

**Give** between one-third to one-half of the total morning dose (both types of insulin).

Patients on continuous insulin infusion (insulin pump) may continue with their usual basal infusion rate, assuming that the catheter and pump can remain safely in place during the procedure.

❖ Start dextrose-containing IV solution to avoid the metabolic changes of starvation.

✓ For patients who develop hyperglycemia, supplemental short- or rapid-acting insulin may be administered subcutaneously

- In a patient with type 1 diabetes who has frequent hypoglycemia or fasting blood glucose levels in the lower end of the normal range, it may be prudent to reduce the night time (supper or bedtime) long- or intermediate acting insulin by 10 to 20 percent on the night prior to surgery to prevent hypoglycemia.

# Long and complex procedures

- IV insulin is usually required for long and complex procedures (eg, coronary artery bypass graft, renal transplant, or prolonged neurosurgical operations)

- Separate insulin and glucose intravenous solutions —  
We prefer separate insulin and glucose IV solutions.  
Rather than infusion
- With this regimen, dextrose is administered at approximately 5 to 10 g of glucose/hour, and a separate insulin infusion is given using shortacting insulin. Most type 1 diabetes patients require an infusion at a rate of 1 to 2 units/hour, while more insulin resistant type 2 diabetes patients can require higher insulin rates

# Post – operative phase

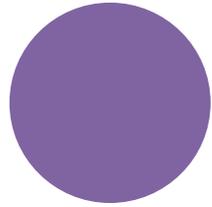
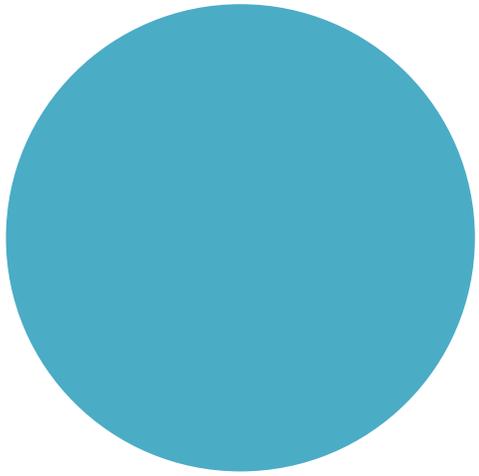
- **Metformin** should not be restarted in patients with renal insufficiency, significant hepatic impairment, or congestive heart failure
- **Sulfonylureas** stimulate insulin secretion and may cause hypoglycemia; they should be started only after eating has been well established
- **Thiazolidinediones** should not be used if patients develop congestive heart failure or problematic fluid retention, or if there are any liver function abnormalities

- If an insulin infusion has been used, it should be continued in patients who do not resume eating postoperatively. Once it seems likely that solid food will be tolerated, the patient can be switched to subcutaneous insulin, and then the insulin infusion can be discontinued

Because of the short half-life of intravenous (IV) regular insulin, the first dose of subcutaneous insulin must be given before discontinuation of the IV insulin infusion

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- If intermediate or long-acting insulin is used, it should be given two to three hours prior to discontinuation,
  - whereas short- or rapidacting insulin should be given one to two hours prior to stopping the infusion

- Patients who were taking subcutaneous insulin in the **early postoperative** phase, before alimentation is restarted, should continue this treatment along with IV dextrose (5 to 10 g of glucose/hour = 100 to 200 mL/hour of dextrose in water or in one-half isotonic saline solution) to prevent hypoglycemia



# **CORRECTION INSULIN**



# Indications –

Varying doses of short- or rapid-acting insulin may be used to supplement usual premeal short- or rapid-acting insulin in patients on prescheduled basal and prandial insulin (basal-bolus insulin) regimens to correct premeal glucose excursions.

In this setting, the additional insulin is referred to as "correction insulin."

" It may also be administered every six hours to prevent hyperglycemia in patients who are nil per os (NPO), supplementing prescheduled basal-bolus insulin.

**Dosing** – Corrective insulin typically is given **when glucose levels are >150 mg/dL (8.3 mmol/L)**, and the amount of insulin depends upon the degree of insulin sensitivity of the patient, caloric intake, and the glycemic target .

Older, lean, type 1 diabetes patients or individuals with renal or liver failure are usually considered to be "insulin sensitive," while obesity or treatment with glucocorticoids are usually associated with an insulin-resistant state.

Smaller doses of insulin are given at bedtime to avoid nocturnal hypoglycemia.



# Hypoglycemia

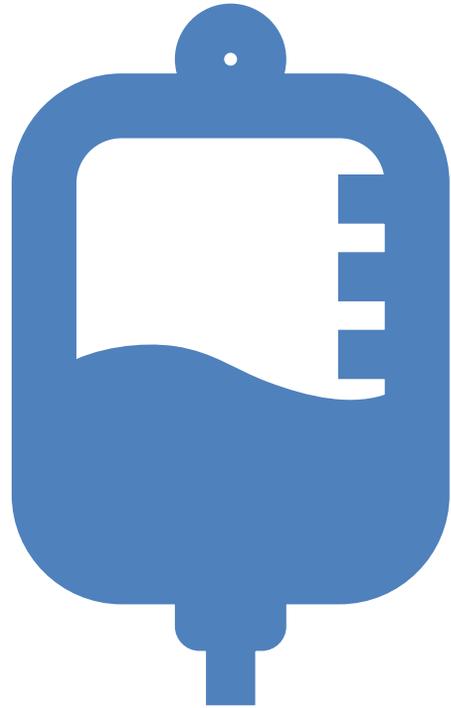
# Goals

The goals in the perioperative setting are:

1- to preoperatively **identify** patients at highest risk for hypoglycaemia.

2- appropriately **adjust** diabetes treatment preoperatively to prevent its occurrence.

**3- monitor** for any episodes of hypoglycemia by measuring glucose levels to ensure prompt treatment.



# Monitoring

- In the perioperative setting, hypoglycemia can be detected through monitoring of blood glucose levels, which are typically checked every one to two hours during surgery (for patients treated with insulin or insulin secretagogues).

- After recovery from anesthesia or sedation, hypoglycemia may be suspected based upon symptoms, including tremor, palpitations, anxiety, sweating, hunger, and paresthesia.
- The hypoglycemic thresholds at which these symptoms occur are very variable. In patients with diabetes, these symptoms of hypoglycemia may occur at glucose levels of <70 mg/dL (3.9 mmol/L).
- Hypoglycemia can also cause cognitive dysfunction, which may occur at plasma glucose concentrations below 60 mg/dL (3.3 mmol/L). More severe neurologic symptoms, including obtundation, seizures, and coma, occur with progressive hypoglycemia

# Management

Depending

Depending upon the blood glucose level, defensive options include:

Repeating

**Repeating the measurement more frequently as needed**

Decreasing

**Decreasing the rate of an insulin infusion or subsequent dose of subcutaneous insulin, and/or**

Administering

**Administering intravenous (IV) dextrose**

- **For a sedated, anesthetized patient** with a blood glucose of  $<70$  mg/dL, we typically administer IV dextrose (25 g) and repeat blood glucose measurements in 5 to 10 minutes.
- In the **awake patient with a normal swallowing** mechanism and gag reflex, symptomatic hypoglycemia is typically treated with at least 15 g of carbohydrates (glucose tablet, sweetened fruit juice).
- In **patients unable to take anything by mouth**, hypoglycemia can be treated by giving 25 g of 50 percent glucose (dextrose) intravenously.

Special conditions

# Glucocorticoid therapy



- Glucocorticoids worsen preexisting diabetes mellitus and may precipitate steroid-induced hyperglycemia in patients without preexisting diabetes.
- However, the magnitude of the hyperglycemic response depends on the dose of glucocorticoids.



Oral hypoglycemic medications can be used in patients with a constant dose of steroids and minimal elevation in blood glucose;

Insulin is necessary for those whose glucose levels are elevated ( $>200$  g/dL or 11 mmol/L) and for patients who are started on large doses of steroids or that have their dose increased significantly.

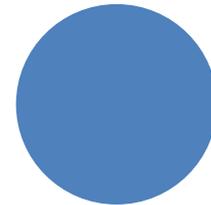
## Hyperalimentation

TPN [Total parenteral nutrition](#) will often increase the serum blood glucose and necessitate large doses of insulin to maintain glycemic control in diabetic patients.

Some investigators recommend using a variable-rate insulin infusion when the patient is first started on TPN. Once the patient is on a stable infusion rate of TPN, he/she may have the daily requirement of insulin directly added to the TPN solution bag.

- When emergency surgery is required in a patient with diabetes whose glucose levels are very high (for example, greater than 250 mg/dL [13.9 mmol/L]) or low enough to threaten hypoglycemia (<100 mg/dL [5.5 mmol/L]), blood glucose levels should be monitored with fingerstick or whole venous blood methods at least every hour and more frequently for blood glucose levels <70 mg/dL (3.9 mmol/L).

## Emergency procedures





Many patients with type 1 diabetes and very elevated glucose levels may be managed most conveniently with an IV insulin infusion through a reliable IV access.

For patients with type 2 diabetes and elevated blood glucose levels (>250 mg/dL [13.9 mmol/L]) who require emergency surgery, we treat with an IV insulin infusion or subcutaneous insulin.

- For **long procedures, an insulin infusion is preferred.** If the patient had been using a long- acting basal insulin (eg, glargine, degludec) once daily or a continuous infusion of short- or rapid- acting insulin (insulin pump), it should be continued along with the IV insulin infusion or additional corrective subcutaneous insulin.

# Resources



UP TO DATE



AMERICAN DIABETIC  
ASSOCIATION

**Thank you.**