# Practical advice for perioperative management in diabetes

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*Patients with diabetes have increased risks of mortality and morbidity following surgery. Optimal management during the perioperative period may reduce the risk of adverse outcomes postoperatively. By working together as a team, the surgeon (or proceduralist), anaesthetist, GP and/or endocrinologist can ensure the best surgical outcomes for each patient.*

Diabetes mellitus is a common metabolic disease, and its prevalence continues to rise.[1] Fifteen years ago, the Australian Diabetes, Obesity and Lifestyle (AusDiab) Study demonstrated that diabetes affected 7.5% of Australians aged 25 years or older, and that there is one person with undiagnosed diabetes for every person with known diabetes.[2] Whether diagnosed or not, diabetes is a major independent risk factor for vascular complications, including cardiovascular disease, renal failure, blindness from retinopathy, lower limb infections and amputations.[3-5] Between 2000 and 2005, the rate of hospitalisation related to diabetes increased by 35%, and patients with diabetes had a longer length of stay in hospital than patients without diabetes.[1] Patients with diabetes undergoing surgery often have unstable glycaemic control during the perioperative period, which may have an impact on their recovery and length of stay in hospital.

To date, there has been no consensus in the management of patients with diabetes undergoing surgery.[6,7] However, in 2012 the Australian Diabetes Society (ADS) released *Peri-operative Diabetes Management Guidelines* (available online at: https://diabetessociety.com.au/documents/PerioperativeDiabetesManagementGuidelinesFINALCleanJuly2012.pdf).[3] This article is based mainly on the ADS guidelines. To best manage patients with diabetes during surgery and achieve good outcomes, effective communication and teamwork are required between all clinicians involved in the care of an individual patient.



## Keypoints

- **For patients with diabetes, the metabolic impacts of surgery, fasting and interruptions to usual therapy contribute to poor glycaemic control, which may result in increased length of hospital stay and risks of morbidity and mortality.**
- **Prevention of hyperglycaemia as well as hypoglycaemia may reduce the risk of adverse outcomes for patients with diabetes undergoing surgery.**
- **Clear instructions should be given to patients before their procedure regarding how their diabetes medications will need to be modified on or before the day of surgery.**
- **More frequent monitoring of blood glucose levels should be performed during the perioperative period. Good discharge planning and early review of the patient's diabetes control after surgery is recommended, especially if the glycaemic profile is erratic.**
- **Effective communication between all clinicians involved in an individual patient's care is important for ensuring good outcomes.**

ENDOCRINOLOGY TODAY 2015; 4(4): 17-20

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**1. Potential benefits of improving glycaemic control during the perioperative period***

- Control of hyperglycaemia-induced osmotic diuresis
- Enhanced wound healing
- Altered balance between proinflammatory and anti-inflammatory mediators due to insulin therapy, which:
  - suppresses tumour necrosis factor-α
  - decreases intranuclear factor κB
  - decreases free radical formation
  - decreases p-47 protein
  - decreases plasma soluble intercellular adhesion molecules
  - decreases monocyte chemoattractant protein-1
  - decreases plasminogen activator inhibitor-1 concentrations
  - enhances nitric oxide formation
  - enhances vasodilatory prostanoid formation

  and due to glucose normalisation, which:
  - decreases free radical production
  - modulates nitric oxide formation
- Maintenance of macrophage and neutrophil function
- Enhanced erythropoiesis and reduced haemolysis
- Reduced neuropathy (axonal dysfunction and degeneration)

* Adapted from Coursin et al, 2004 (reference 14).

The perioperative management of pregnant women taking insulin therapy (those with pre-existing diabetes or gestational diabetes on insulin therapy) during labour requires a different protocol and is beyond the scope of this paper.

## Why maintain normal glucose levels during the perioperative period?

Hyperglycaemia from surgery can be due to a number of factors. The trauma of surgery itself results in increased secretion of stress hormones, particularly cortisol and catecholamines, which reduce insulin sensitivity.[8-10] Elevated sympathetic response leads to reduced insulin secretion and to increased glucagon and growth hormone secretions.[6,11,12] These processes trigger a catabolic response in a patient with diabetes, resulting in gluconeogenesis, glycogenolysis, proteolysis, lipolysis and ketogenesis, which in turn lead to hyperglycaemia and ketosis. Moreover, most anaesthetic agents can induce hyperglycaemia as well.[6]

Hyperglycaemia affects the cellular immune function, stimulates inflammatory cytokines, disturbs microcirculation and impairs wound healing.[13,14] Hyperglycaemia in hospitalised patients is associated with poorer clinical outcomes, with higher incidence of postoperative morbidity and mortality[6,15-18] and prolonged length of stay in hospital.[3,19] In patients with diabetes who undergo coronary artery surgery, perioperative hyperglycaemia is an independent predictor of short-term infectious complications, including sternal wound, urinary tract and chest infections.[20-22] This risk is twice as high if the $HbA_{1c}$ is greater than 7.0%.[3,23] Maintaining good glycaemic control may minimise some of the effects of hyperglycaemia and improve outcomes of surgery (see Box 1).[6,24-26] Avoidance of hypoglycaemia is also a priority, with results of a large intensive care unit study demonstrating that moderate and severe hypoglycaemia is associated with death.[27]

## What should we aim for?

The main aims of perioperative management of diabetes are to avoid excessive hyperglycaemia, hypoglycaemia and ketosis, and to thus reduce morbidity and mortality.[6] Prior to surgery, clinicians should aim to establish good glycaemic control by keeping $HbA_{1c}$ at less than 7.0%. Consideration should be given to postponing or deferring elective surgery if $HbA_{1c}$ exceeds 9.0%.[3]

The optimal target range of capillary blood glucose level (BGL) in the postoperative period is debatable and may depend on the clinical context. Although maintaining BGL between 4.4 and 6.1 mmol/L using insulin therapy in the intensive care unit setting has been shown to significantly reduce morbidity and mortality in a Belgian study,[28] very tight glycaemic control has been shown to increase mortality in another study.[29] Given the evidence for impaired neutrophil function with BGL higher than 11 mmol/L, a postoperative BGL target of 5 to 10 mmol/L is recommended in the ADS guidelines and avoidance of hypoglycaemia is also a priority.[3] More frequent monitoring of BGL by the patient and nursing staff should be performed on the days before surgery as well as following the procedure.[3,6]

## Type 1 or type 2 diabetes?

Distinguishing between type 1 and type 2 diabetes can sometimes be difficult, especially in patients who have been taking insulin therapy long term. Insulin-deficient patients (those with type 1 diabetes or with long-term type 2 diabetes on multiple insulin injections) tend to be more metabolically stressed from surgery, and such patients are prone to complications such as diabetic ketoacidosis if insulin is omitted.[6,10] To avoid confusion among medical and nursing staff, the same management protocol should be used for all patients who require insulin therapy.

## Preoperative considerations

Before a patient undergoes surgery, the doctor who usually manages his or her diabetes (GP or endocrinologist) should be informed of the forthcoming procedure to allow optimisation of diabetes control, if necessary. The patient should be given clear verbal and written instructions regarding the modification of diabetes medications before surgery.

Special consideration should be given to significant diabetes complications. For example, patients with gastroparesis may need a prolonged fasting period and their ability to resume normal oral intake may be delayed following surgery. Patients with unstable cardiovascular disease have an increased operative risk, and they will require presurgical evaluation and optimisation of their cardiac status. Routine perioperative use of beta blockers for noncardiac surgery is not recommended for patients with diabetes.[3,30] For those with diabetic nephropathy and impaired renal function, the use of nephrotoxic agents (such as intravenous contrast) should be minimised and patients should be kept well

hydrated to reduce further renal injury.

Patients with diabetes should have their surgical procedure performed in the morning, rather than the afternoon, as this is less disruptive to their usual diabetes management routine. It is preferable for patients with diabetes to be placed at the top on the operating list.

## The procedure

### Patients with diabetes on insulin therapy (with or without anti-hyperglycaemic medications)

Patients with diabetes controlled by insulin who are undergoing major surgery (i.e. a procedure that requires at least an overnight admission) and are on the morning list should take their usual antihyperglycaemic medications (this includes glucagon-like peptide 1 agonist) and usual insulin (basal, bolus or premixed) on the day before surgery and fast from midnight. For patients who have very tight glycaemic control (e.g. $HbA_{1c}$ <6.5% or fasting BGL <5.0 mmol/L), consideration should be given to reducing the insulin doses by 10 to 20% the day before surgery to avoid hypoglycaemia.

On the day of surgery, patients should refrain from taking anti-hyperglycaemic medications and omit their usual morning insulin dose. Often, patients will be commenced on an insulin–glucose (IG) infusion before induction of anaesthesia. An IG infusion is a very effective way to maintain tight glycaemic control during the perioperative period.[7] In most IG infusion protocols, intravenous glucose is given at a fixed rate (e.g. 80 mL/hour) while the insulin infusion rate is adjusted to maintain the BGL within a desired range. An IG infusion should be continued for at least 24 hours postoperatively and until the patient resumes an oral diet. When the patient is eating and drinking normally, he or she can resume their usual insulin and other anti-hyperglycaemic medications.

### 2. Modifying diabetes management for patients undergoing minor surgery*

The Table below describes suggested modifications for usual diabetes management for patients who are undergoing minor surgery (i.e. a day-only procedure). This information applies to patients with diabetes who are taking insulin with or without antihyperglycaemic medications (i.e. oral diabetes medication and/or glucagon-like peptide 1 agonist).

Part A of the Table applies to patients with surgery scheduled for the morning, when patients are asked to fast from midnight prior to surgery. Part B of the Table applies to patients with surgery scheduled for the afternoon, when the patient can have a light breakfast between 6 am and 7 am and fast after that on the day of surgery. Afternoon surgery is not ideal because it is more disruptive to a patient's usual diabetes management routine than morning surgery. It is preferable for patients with diabetes to be placed at the top on the operating list.

Note that the suggested modifications are of a general nature only. A patient's endocrinologist or GP should determine how each individual's diabetes therapy is altered perioperatively.

**Table. Suggested changes to usual insulin regimen**

| **Part A. For patients with minor surgery scheduled for the morning** | |
|---|---|
| **Example of usual insulin regimen** | **Suggested modifications** |
| Antihyperglycaemic medication and night time basal insulin (detemir/glargine/isophane) | Stop antihyperglycaemic medication and give usual dose of insulin the night before. May reduce dose of basal insulin by 10 to 20% if recent fasting BGL consistently <5.0 mmol/L |
| Meal time bolus insulin and night time insulin glargine | May reduce dose of glargine by 10 to 20% the night before surgery if recent fasting BGL consistently <5.0 mmol/L and omit bolus insulin on the morning of surgery |
| Meal time bolus insulin and night time intermediate-acting insulin (detemir/isophane) | Give half the combined morning and lunch time bolus insulin dose but give as intermediate-acting insulin (determir/isophane) in the morning |
| Meal time bolus insulin and morning basal insulin (detemir/glargine/isophane | Omit bolus insulin in the morning and give usual morning dose of basal insulin |
| Twice daily premixed insulin | Give half the usual morning premixed insulin dose (but patient will be at risk of hypoglycaemia) or<br>Give half the usual morning dose but using an intermediate-acting insulin (detemir/isophane), if available at the facility |
| **Part B. For patients with minor surgery scheduled for the afternoon** | |
| **Example of usual insulin regimen** | **Suggested modifications** |
| Antihyperglycaemic medication and night time basal insulin (detemir/glargine/isophane) | Stop antihyperglycaemic medication and give usual dose of insulin the night before. May reduce dose of basal insulin by 10 to 20% if recent fasting BGL consistently <5.0 mmol/L |
| Meal time bolus insulin and night time insulin glargine | Give half the morning bolus insulin before light breakfast on morning of surgery, plus give usual dose of insulin glargine the night before surgery. May reduce dose of basal insulin by 10 to 20% if recent fasting BGL consistently <5.0 mmol/L |
| Meal time bolus insulin and night time intermediate-acting insulin (detemir/isophane) | Give half the morning bolus insulin before light breakfast, plus a small dose of intermediate-acting insulin (detemir/isophane) in the morning (e.g. 50% of total day time bolus insulin) |
| Meal time bolus insulin and morning basal insulin (detemir/glargine/isophane) | Give half the morning bolus insulin before light breakfast, plus half the basal insulin in the morning of surgery |
| Twice daily premixed insulin | Give half the usual morning premixed insulin dose before light breakfast |

* Based on ADS Diabetes Perioperative Management Guidelines, 2012 (reference 3). Abbreviation: BGL = blood glucose level.

At institutions where there is no IG infusion protocol, the use of subcutaneous insulin doses can be considered, as per minor surgery discussed below. However, the BGL must be carefully monitored during surgery so that intravenous glucose or insulin can be given if the patient's glycaemic status becomes unstable.

Patients with diabetes on insulin who are undergoing minor surgery (i.e. a day-only procedure) in the morning can take their morning insulin on the day of the procedure but the dose should be reduced (Table, Part A). If the procedure is expected to be short and the recovery quick, the usual morning insulin dose can be given with a late breakfast following the procedure. An IG infusion should be considered if the patient's glycaemic status is unstable (BGL ⩾10 to 15 mmol/L), if the surgery is prolonged or if he or she is unable to resume eating immediately following surgery – in these situations the patient will need at least an overnight hospital stay. Otherwise, they can resume their usual insulin doses and antihyperglycaemic medications when they start eating postoperatively.

In the less ideal situation whereby the patient is scheduled for afternoon surgery, a more complex modification of the insulin regimen may be required (Table, Part B).

Patients with type 1 diabetes who are on subcutaneous insulin pump therapy can continue their insulin pump during the perioperative period for minor procedures. This is achieved by maintaining the basal rates and omitting the bolus doses until they are ready to eat. However, for patients undergoing major surgery and patients who need to remain nil by mouth for long periods of time, an IG infusion will be able to achieve stable glycaemic control safely.

### Patients with diabetes taking antihyperglycaemic medications

Patients with diabetes taking antihyperglycaemic medications (without insulin) should omit their medications on the day of their operation and resume these when they are once again eating. This applies to oral antihyperglycaemic medications as well as to glucagon-like peptide 1 agonists. If BGLs are elevated above 10 mmol/L, an IG infusion may be considered.

Patients taking metformin can recommence this drug when they resume eating, unless their renal function deteriorates significantly postoperatively. However, in patients with borderline renal function who require intravenous contrast, some radiological service providers request withholding metformin for 24 hours before the procedure and restarting metformin at least 48 hours post-procedure (or until renal function is stable). In these cases, alternative agents for glycaemic control maybe considered to prevent hyperglycaemia from prolonged cessation of metformin.

### Patients with diabetes managed by diet alone

Patients with diabetes managed by diet alone generally require no specific perioperative management. However, if BGL persists above 10 mmol/L prior to surgery, an IG infusion or subcutaneous insulin may be considered during the perioperative period. After the procedure, they may need to be commenced on regular insulin or antihyperglycaemic medication upon resuming oral diet.

## Postoperative management

It is important to ensure that patients can self-manage their diabetes following surgery and that they have access to assistance if needed. During the postoperative period, requirements for diabetes medications may fluctuate, depending on the metabolic impact of the procedure, the presence of pain or infection and the adequacy of oral intake. Although this is difficult to anticipate, the best approach is for patients to resume their usual diabetes medications following surgery and for doctors to provide additional treatment (e.g. insulin) if their glycaemic control becomes unstable. If patients require a prolonged stay in hospital and if their glucose profile is erratic, a basal–bolus insulin regimen (rapid-acting insulin with each meal and basal insulin at night) is highly effective in stabilising glycaemic control.[31] This can be implemented in the hospital ward, but it may not be easy to continue four insulin injections a day for many patients following discharge.

After leaving hospital, patients who have a blood glucose meter should monitor their BGLs frequently (3 to 4 times per day if possible). Early review with their GP or endocrinologist should be arranged so that the treatment regimen can be adjusted if needed.

## Bowel preparation

Patients who require colonoscopy or bowel surgery need to undergo bowel preparation, which involves a clear fluid diet and/or laxatives. Patients with diabetes are advised to monitor their BGL more frequently (two-hourly) and to take glucose-containing clear fluid but antihyperglycaemic medications should be withheld during this period because their carbohydrate intake will be reduced.

Patients on insulin therapy should seek advice from their GP or endocrinologist for adjustment of their insulin regimen. For instance, patients on a basal–bolus insulin regimen may be advised to withhold bolus insulin but continue basal insulin. Patients on premixed insulin are advised to take half their usual doses. The advice may differ for different clinicians and will need to take into account the circumstances of each individual patient.

## Conclusion

Achieving good perioperative glycaemic control is important for patients with diabetes and may reduce postoperative complications. Managing patients with diabetes during the perioperative period can be complex, but with adequate planning, effective communication between the different clinicians involved in the patient's care and the use of simple, clear protocols will help ensure good surgical outcomes and minimise complications. **ET**

### References

A list of references is included in the website version of this article (www.medicinetoday.com.au).

COMPETING INTERESTS: None.

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