ADS-ANZCA Perioperative Diabetes and Hyperglycaemia Guidelines (Adults)

Guidelines of the Australian Diabetes Society (ADS) and the Australian and New Zealand College of Anaesthetists & Faculty of Pain Medicine (ANZCA).

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1. EXECUTIVE SUMMARY OF PROTOCOL

The following serves as a guideline for most patients but does not preclude specific individualised management. Please refer to page 10 for definitions and acronyms used in this document.

1.1 Primary Referral Process

1. The primary referrer, usually the GP, should complete all referrals for surgery. The referral letter should include details of any diabetes-related complications and medications. Relevant laboratory measurements must be included.
2. The primary referrer should initiate assessment and optimisation of the patient's glycaemic control. This includes the following recommendations:
    a. HbA1c should be measured within the preceding 3 months (preferably within 4-6 weeks prior).
    b. Referral to a diabetes specialist should be made if feasible, when HbA1c is ≥ 70 mmol/mol (8.5%) or when there is hypoglycaemic unawareness.
    c. Target HbA1c < 75 mmol/mol (9%), should ideally be achieved prior to elective surgery.
    d. Capability of patient / carer should be ensured to measure and record fingerprick blood glucose levels (BGLs) to facilitate diabetes stabilisation and peri-operative management. This should include ensuring access to a glucose meter and blood glucose testing strips (usually via NDSS).
    e. A *written* peri-operative management plan should be provided to the patient. This is usually the responsibility of the Pre-Admission Anaesthetist or the diabetes physician.

1.2 Pre-operative Management

1.2.1 Pre admission

1. A written peri-operative management plan should be provided to all patients with diabetes.
2. Patients should not drive on the morning of surgery, or for 24 hours after sedation or anaesthetic.
3. Clear instructions should be provided for patients on oral fluids only, such as:
    a. Drink only water for hydration.
    b. Drink water until 2 hours prior to surgery.
    c. Clear (not cloudy) apple juice can be used for hypoglycaemia management.
4. People with diabetes on non-insulin anti-hyperglycaemic medications should:
    a. Cease SGLT2 inhibitors (SGLT2i) on the two days prior to surgery and the day of surgery. Supplementary alternative anti-hyperglycaemic medications may need to be given to avoid excessive hyperglycaemia.
    b. For colonoscopy, cease SGLT2 inhibitors (SGLT2i) on the two days prior to the procedure and the day of colonoscopy. Usually supplementary alternative anti-hyperglycaemic medications will not be needed given fluids only on the 2nd day.
    c. For day-stay procedures (including gastroscopy), SGLT2i can be stopped just for the day of procedure. However, duration of fasting before and after the procedure should be minimised.
    d. Continue all other anti-hyperglycaemic medications up to and including the night before surgery.
    e. Withhold all oral anti-hyperglycaemic and non-insulin medications on the day of surgery.
    f. Bring their blood glucose meter and latest BGL record.

5. People with diabetes managed with insulin should:
    a. Continue the usual insulin regimen up to and including the night before surgery.
    b. Continue basal insulin at usual dose(s) and time(s). Exception: Reduce basal insulin dose by 20% if recent overnight hypoglycaemia (*refer to Appendix K*).
    c. If pre-mixed insulin, continue usual evening meal dose the evening prior to surgery. Exception: Reduce evening insulin dose by 20% if recent overnight hypoglycaemia. Reduce morning dose by 50% on the day of surgery, omit lunchtime dose (if any) and resume usual insulin regimen from the evening after surgery if eating (*refer to Appendix K*).
    d. If co-formulated insulin, continue usual evening meal dose the evening prior to surgery. Exception: Reduce evening insulin dose by 20% if recent overnight hypoglycaemia. If morning procedure delay any morning dose to lunchtime (if able to eat by then) or delay till evening if not usually on evening dose. If usually lunchtime co-formulated insulin continue usual dose after morning surgery if eating or delay till evening if not usually on evening dose. If usually lunchtime co-formulated insulin and afternoon surgery, delay till evening (if eating) if not usually on evening dose. If usually evening co-formulated insulin continue usual dose after surgery if eating. If not eating (*refer to Appendix K*).
    e. Have written instructions for changes to their insulin regimen on the day of surgery (*refer to Appendix E).*
    f. Bring their blood glucose meter and latest BGL record and/or printout from flash or continuous glucose monitoring systems.
6. People with diabetes on Insulin pump therapy should:
    a. Bring a printed record of their latest pump settings.
    b. Continue basal insulin infusion via pump throughout surgery, except where the patient is to remain nil by mouth post-surgery in which case an intravenous insulin-glucose infusion is recommended.
    c. Perform a line and set change 24 hours before surgery and record all BGL checks to ensure the pump is functioning normally.
    d. Set a temporary basal rate of -20% (or 80% of basal) if HbA1c < 48 mmol/mol (6.5%) or if fasting glucose is <5 mmol/L on the day of the procedure.
    e. If auto-mode pump individualised advice from diabetes physician required regarding appropriate blood glucose to be set perioperatively. Consider 6.7mmol/L or exercise type target of 8.3mmol/L..
    f. Bring their blood glucose meter and latest BGL record and/or printout from flash or continuous glucose monitoring systems.
7. Pre-admission hyperglycaemia of >12 mmol/L should be corrected by the patient if they usually use a rapid acting insulin. Repeat correctional insulin doses should not usually be administered within 3 hours of each other.

1.2.2 Post-admission

1. Following admission to hospital, glucose monitoring should generally be done hourly while fasting and during the procedure.
2. Fluid replacement:
    a. Isotonic solutions such as 0.9% Saline, Hartmann's or Plasmalyte can be used for hydration.
    b. Glucose-containing fluid needs to be used only for treatment of hypoglycaemia or when using an insulin infusion e.g. extended procedure or when the person needs to remain fasting following the procedure.
3. Sodium and potassium level should be monitored at least daily and especially when on insulin infusions.

4. Hypoglycaemia (BGL <4.0 mmol/L) must be avoided. Treatment to avoid hypoglycaemia (infusion with 5% glucose solution or boluses of more concentrated solutions e.g., 10%, 20% or 50% glucose) should begin when BGL <5.0 mmol/L.
5. Glucose monitoring and decision making to be by fingerprick capillary blood in the perioperative period - not by flash or continuous glucose monitoring devices even if worn. Blood glucose target is **7.5 ± 2.5 mmol/L** except for:
    a. Pregnancy: 5.0 ± 1.0 mmol/L
    b. Emergency surgery with poor glycaemic control: 10.0 ± 2.5 mmol/L
    c. Known hypoglycaemia unawareness: 10.0 ± 2.5 mmol/L
6. Bowel Preparation
    a. Patients able to monitor their own BGL should be advised to do so 2-4 hourly from the time they start fasting.
    b. BGL target and management as per above. Clear apple juice and sugar-containing cordial (not artificial sweeteners) or jelly (not red, blue or orange in colour) should be used for avoidance of, and correction of, hypoglycaemia.
    c. Insulin regimens should be changed, and written instructions provided *(refer to Appendix E)*.

1.3 Intra-operative Management

1. BGL should be monitored hourly, increasing in frequency if it trends off-target.
2. Consider treating hyperglycaemia when BGL >10 mmol/L with correction dose of insulin delivered subcutaneously.
3. Consider commencing variable rate insulin infusion (VRII) when BGL is rapidly rising and/or >12 mmol/L. VRII rates should be based on local protocol.
4. Determination of correctional insulin doses should be based on patient's usual insulin sensitivity (correction) factor (refer to Section 5.2.4).
5. In patients with type 1 diabetes, blood gas and blood ketones should be measured to check for possible ketoacidosis if BGL > 15 mmol/L.
6. If patient has taken SGLT2i within 72 hours and is unwell, blood gas and blood ketones should be measured to check for possible ketoacidosis regardless of BGL.
7. Dexamethasone is useful for prevention but not treatment of nausea and vomiting. Due to the associated glucocorticoid-induced hyperglycaemia, use of other anti-emetics in people with diabetes is recommended.

1.4 Post-operative Management

1. BGL should be monitored hourly until the patient leaves the recovery area.
    a. If the BGL has been stable (within target range), BGL monitoring can be decreased to 2 hourly for patients with type 1 diabetes, or 2-4 hourly for patients with type 2 diabetes.

    In cardio-thoracic surgery patients or in patients admitted to the intensive care unit, it is recommended a VRII be commenced if two post-operative BGL >10 mmol/L are recorded.
2. VRII can be ceased if *ALL* of the following are met.
    a. There is no evidence of diabetic ketoacidosis.
    b. The patient is eating well (tolerating 50% of normal oral intake/has commenced enteral feeds) or is on Total Parenteral Nutrition (TPN).
    c. The patient's usual diabetes therapies (insulin and non-insulin) have been resumed – in particular basal insulin for insulin treated patients.

d. A management plan for glycaemic control has been implemented at least two hours before discontinuing the VRII.

3. Ideally, VRII should be ceased after breakfast, with a dose of subcutaneous insulin (or oral anti hyperglycaemic medication-AHG) having been given before breakfast.

4. Basal bolus insulin regimen (or 'supplemental insulin protocol'), given in addition to the patient's usual diabetes medication, should be used in place of 'sliding scale insulin'.

5. Patients with preoperatively impaired renal function should have serum creatinine levels checked post-operatively.

6. Patients should recommence their usual management (AHG and/or insulin) once they recommence eating and drinking, with the following exceptions:

   a. Metformin should be withheld in patients with renal impairment [CKD stage 3B or below/eGFR <45 mL/min/1.73 m2] and should only be recommenced once renal function has returned to their baseline level. For patients who can eat and drink immediately after their procedure metformin can be restarted without measuring renal function.

   b. Sodium glucose transport protein-2 inhibitors (SGLT2i) should not be recommenced for at least 2 days after major surgery, and even then, only after the patient has returned to eating a full diet. In the setting of minor surgery, SGLT2i may be recommenced the day after surgery. (Please also refer to your local hospital, area or state guidelines regarding in-hospital prescribing of SGLT2i)

7. At discharge, patients should be provided with contact information for diabetes care support on discharge – this may be their general practitioner or diabetes specialist service as appropriate for the clinical setting.

8. All relevant in-hospital tests and issues with regards to glycaemic control should be conveyed to the patient's GP and specialists.

2. SCOPE, OBJECTIVE, DEFINITIONS AND ACRONYMS

This is a *practical* guideline intended for all health professionals who are directly involved in the care of patients undergoing surgery, including but not limited to: general practitioners, anaesthetists, physicians, surgeons, preoperative clinic staff and allied health professionals, (including diabetes educators). This guideline predominantly addresses peri-operative diabetes management for adult elective surgery in non-pregnant patients, although the general principles will still apply to pregnant patients.

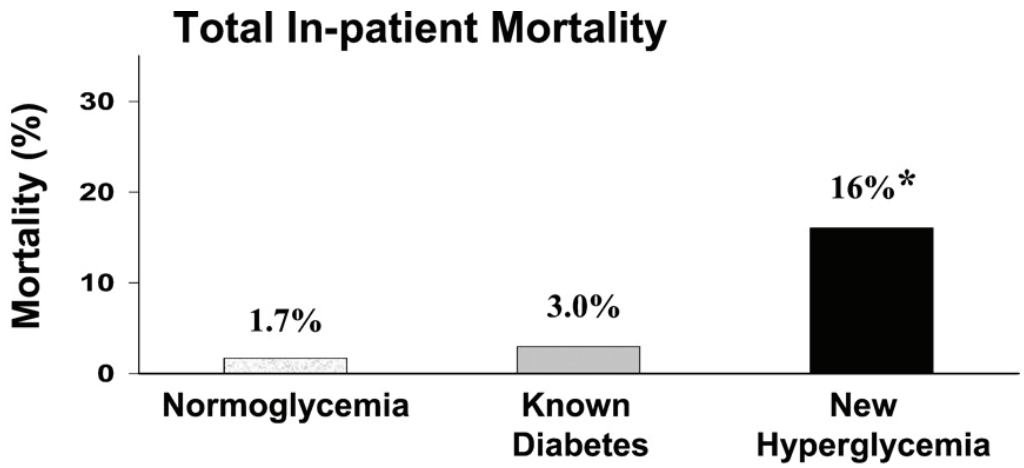


Figure 1- In-patient mortality, showing increased mortality in people with diabetes when admitted to hospital, which increases dramatically when hyperglycaemia is newly detected in hospital[1]

1 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(3):978-982. doi:10.1210/jcem.87.3.8341

This guideline encompasses both people with known diabetes and newly diagnosed peri-operative hyperglycaemia. It is well recognised those with newly diagnosed hyperglycaemia are at greatest risk of adverse outcomes when compared to people with known diabetes (Figure 1). Newly diagnosed hyperglycaemia should be managed as for those with known diabetes. Appropriate post-operative follow-up to assess diabetes status and management is required for all patients with perioperative hyperglycaemia.

This guideline encompasses the entire 'peri-operative journey' starting from referral to post-operative follow-up.

2.1 Person Centred Care

While this guideline is targeted at health professionals, the individual with diabetes plays a central role in their own care and management and must be involved from the primary referral to the postoperative follow-up stages of their care. Person-centred care is especially important in diabetes care, where the person with diabetes may have extensive knowledge of their condition and is self-managing their diabetes.

2.2 Definitions

For the purposes of this document, the following are some of the definitions used

[See Appendix I – Types of Insulin on page 53 for more information]:

Table 1- Definitions of common terms used in the guideline

Terminology	Definition
Basal insulin	The role of basal ('background') insulin is to keep blood glucose levels at consistent levels between meals and during periods of fasting. In people using insulin injections, basal insulin is the intermediate or long acting insulin that is administered once or twice a day to provide for the basal insulin requirements of a patient with diabetes. Insulin glargine (Optisulin™, Toujeo™, Semglee™), Insulin detemir (Levemir™). In people using subcutaneous insulin pump therapy, basal insulin rates are programmed into the pump.
Intermediate-acting insulin	Basal insulin with a shorter duration of action than long-acting insulin. e.g. isophane insulin (Protaphane™, Humulin NPH™).
Bolus insulin	Insulin given 10-15 minutes before meals to cover the meal carbohydrate content or for correction of hyperglycaemia. *Ultra-rapid-acting* (e.g. fast acting insulin aspart-FiAsp™), *Rapid-acting* (e.g. insulin lispro - Humalog™, insulin aspart - Novorapid™, insulin glulisine - Apidra™) or *Short-acting* (e.g. regular insulin: Actrapid™, Humulin R™).
Basal-bolus regimen	An insulin regimen consisting of basal insulin and multiple daily bolus insulin.
Pre-mixed insulin	Single injectable insulin that consists of a mixture of an intermediate-acting insulin and a short acting or rapid acting insulin at a pre-determined fixed ratio. Examples of this would be Novomix™ 30, Mixtard™ 30/70, Humalog Mix™ 25.
Co-formulated insulin	Single injectable insulin that consists of a combination of an ultra-long-acting insulin and a rapid acting insulin at a pre-determined ratio. Ryzodeg™ 70/30
Major surgery	Surgical cases requiring more than one night of hospitalisation post-operatively.

Minor surgery	All day surgical cases and any extended day surgery cases that require only a single night stay in hospital.
Poorly controlled diabetes	HbA1c ≥ 75 mmol/mol (9.0%) OR highly variable blood glucose readings with frequent hypo and hyperglycaemia OR patients with recent severe hypoglycaemia requiring external intervention OR patients with recent acute hyperglycaemic episodes requiring hospitalisation.

Table 2 - Common acronyms used in the guideline

Acronym	Definition
ADS	Australian Diabetes Society
AHG	Anti-hyperglycaemic medication
AUSDRISK	Australian Diabetes Risk assessment tool
bd	Twice a day
BMI	Body Mass Index
BP	Blood Pressure
ANZCA	Australian and New Zealand College of Anaesthetists
BGL	Blood Glucose Level
CKD	Chronic kidney disease
CKD stage (GFR in mL/min/1.73 m2)	Stage 2 Mild CKD (GFR 60-89) Stage 3A Moderate CKD(GFR 45-59) Stage 3B Moderate CKD (GFR 30-44) Stage 4 Severe CKD (GFR 15-29) Stage 5 Severe CKD (GFR < 15 or on dialysis)
DKA	Diabetic Ketoacidosis
DM	Diabetes Mellitus
eGFR	Estimated Glomerular Filtration Rate, using the MDRD (Modification of Diet in Renal Disease) study formula
ERAS	Enhanced Recovery After Surgery
euDKA	Diabetes Ketoacidosis without hyperglycaemia (ie BGL <11.1 mmol/L) - Euglycaemic diabetic ketoacidosis
GP or LMO	General Practitioner or Local Medical Officer
GLP-1	Glucagon-like peptide-1
HHS	Hyperosmolar Hyperglycaemia State (also commonly referred to as HONK or Hyperosmolar Non-Ketotic Coma)
ISF	Insulin sensitivity factor
ICU	Intensive care unit
SGLT2i	Sodium-glucose co-transporter 2 inhibitor
SC	Subcutaneous
TPN	Total Parenteral Nutrition
VRII	Variable rate insulin infusion

3. INTRODUCTION

Diabetes is the most common metabolic disorder in Australia with an estimated 1.4 million people diagnosed with the condition[2]. At least another 2 million have "pre-diabetes" with impaired glucose metabolism. Over 280 Australians are diagnosed with diabetes every day (more than 100,000/year).[3] Furthermore, it is estimated that 500,000 Australians have undiagnosed type 2 diabetes. This high number suggests that for every ten people with diagnosed diabetes, four additional people would have undiagnosed diabetes. At any one time, up to 25% of hospital inpatients have diabetes[4].

3.1 Diabetes Mellitus and Surgery

Diabetes leads to increased morbidity and increased length of stay, regardless of the admission specialty, thereby increasing inpatient costs[5]. Moreover, the peri-operative mortality rate is reported to be up to 50% higher than in people without diabetes[6].

Glycaemic control is important peri-operatively and suboptimal glycaemia is associated with:

- Increased post-operative infection risk [5,7,8] and
- Poor wound healing after surgery[5,6,9]

Hypoglycaemia has also been associated with increased mortality[10].

3.2 Diabetes as a Multi-system Disease

Diabetes is a multi-system disease, and complications associated with diabetes need to be considered in the peri-operative setting. In addition to achieving optimal glycaemic control, the following complications associated with diabetes need to be considered in the peri-operative setting:

2 Australian Institute of Health and Welfare 2014. Cardiovascular disease, diabetes and chronic kidney disease— Australian facts: Prevalence and incidence. Cardiovascular, diabetes and chronic kidney disease series no. 2. Cat. no. CDK 2. Canberra: AIHW.

3 Diabetes in Australia. https://www.diabetesaustralia.com.au/diabetes-in-australia. Accessed 15 May, 2022

4 Bach LA, Ekinci EI, Engler D, *et al*. The high burden of inpatient diabetes mellitus: the Melbourne Public Hospitals Diabetes Inpatient Audit. *Med J Aust* 2014; 201(6):334-338

5 Kwon S, Thompson R, Dellinger P, *et al*. Importance of Perioperative Glycemic Control in General Surgery: A Report From the Surgical Care and Outcomes Assessment Program. *Ann Surg* 2013; 257(1): 8–14**.**

6 Frisch A, Chandra P, Smiley D, *et al.* Prevalence and clinical outcome of hyperglycemia in the perioperative period in noncardiac surgery. *Diabetes Care* 2010; 33(8):1783-1788

7 Umpierrez GE, Smiley D, Jacobs S, *et al.* Randomized study of basal-bolus insulin therapy in the inpatient management of patients with type 2 diabetes undergoing general surgery (RABBIT 2 surgery). Diabetes Care 2011; 34(2):256-261

8 Chiang HY, Lin KT, Hsiao YL, *et al*. Association Between Preoperative Blood Glucose Level and Hospital Length of Stay for Patients Undergoing Appendectomy or Laparoscopic Cholecystectomy - Diabetes Care 2020; 44(1):107-115

9 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(2):352-360-362

10 Johnston L, Kirby JL, Down EA, *et al.* Postoperative Hypoglycemia Is Associated With Worse Outcomes After Cardiac Operations. *Ann Thorac Surg* 2017; 103(2):526-532

Table 3 - Management considerations for diabetes related complications

Body system & complication	Complication risk	Management consideration
Cardiovascular disease	Myocardial infarction Arrhythmia	▪ Low threshold to evaluate for myocardial ischaemia. ▪ Appropriate primary or secondary preventative medications: beta-blockers, lipid-lowering therapy, anti-platelet therapy. ▪ Hypertension management. ▪ Smoking cessation. ▪ Method of diabetes therapy.
	Cerebrovascular disease	▪ Appropriate preventative medications: lipid-lowering therapy, ACE inhibitor or ARB, anti-platelet therapy if appropriate. ▪ Blood pressure (BP) management. ▪ If history of transient ischaemic attack, needs full work-up prior to surgery.
	Heart failure	▪ Low threshold to evaluate if symptomatic or reduced functional capacity
Peripheral Vascular Disease	▪ Infection ▪ Ulcers ▪ Poor wound healing	▪ Foot and heel protection. ▪ Pressure area care post-operatively. ▪ Close monitoring of wound site.
Peripheral Neuropathy	▪ Infection ▪ Ulcers ▪ Poor wound healing	▪ Same as for peripheral vascular disease.
	▪ Pain	▪ Address prior to surgery if possible. ▪ Rehabilitation with allied health input. ▪ Use of medications for neuropathic pain such as pregabalin.
Autonomic Neuropathy	Incontinence from bladder dystonia	▪ Appropriate nursing care especially post-operatively.
	Gastroparesis	▪ Review diet - recommend frequent small meals with low fibre content. ▪ Consider pro-kinetic agents in the short term e.g. metoclopramide (10 mg tds ac), domperidone (10 mg tds ac). ▪ Minimise medications that slow the gut, e.g. opioids.
	Postural hypotension	▪ Rehabilitation with allied health input. ▪ Ensure good hydration. ▪ Measure postural BP post-operatively. ▪ Assisted or stand-by assisted ambulation immediately post-op. ▪ Consider mineralocorticoid treatment where severe to aid ambulation.
	Prolonged QT syndrome	▪ Baseline ECG. ▪ Review medication list (refer to section 6.8 on page 28). ▪ Alert anaesthetist re prolonged QT. ▪ Avoid droperidol and ondansetron.
Nephropathy	Renal impairment	▪ Monitor renal function before and after surgery. ▪ Ensure adequate pre-operative hydration by minimising fasting period for liquids. ▪ Maintain strict fluid balance chart post-operatively. ▪ Ensure adequate hydration post-operatively with oral or intravenous fluids. ▪ Monitor potassium levels daily.
Retinopathy	Reduced visual acuity	Consider post-operative care with good room lighting, assisted ambulation. Check diabetes self-management ability.

3.21 Cardiovascular disease

- Peri-operatively, diabetes is associated with increased risk of cardiovascular events and prolonged QT syndrome.
- Optimal glycaemic control may reduce the risk of cardiovascular events.

The Framingham study[11] showed that men and women with diabetes have 2.4-5.1 times greater risk of myocardial infarction. The acute stress of surgery is likely to compound this risk. Incidence of post-operative myocardial ischaemia is increased in patients with diabetes, and it appears that good glycaemic control may offset some of this risk[12,13,14].

Patients with diabetes may also develop prolonged QT syndrome. Patients need to be actively screened pre-operatively as it guides medication use peri-operatively including for anaesthesia. Please refer to section 6.8 on page 28 for more information. Prolonged QT syndrome is associated with autonomic neuropathy (see section 3.2.5 below).

3.2.2 Peripheral arterial disease

- Peripheral arterial disease in patients with diabetes is associated with higher risk of cardiovascular events and stroke.

Peripheral arterial disease is present in a significant proportion of patients with diabetes and is associated with higher risk for cardiovascular disease[15]. The major cause of mortality in these patients is attributable to coronary heart disease and to a smaller extent it is attributable to stroke.

3.2.3 Renal disease

- Diabetic nephropathy is common and peri-operatively patients may be at risk of acute kidney injury.

The leading cause of chronic kidney disease in Australia is diabetic nephropathy[16]. This develops in about 40% of people with type 1 diabetes, and in 20-40% of people with type 2 diabetes [17,18]. Renal disease often becomes apparent in situations of acute stress, such as with surgery, infection and/or dehydration from fasting without fluid intake or inability to drink to thirst post-operatively. This can occur in conjunction with medications which may be nephrotoxic in the person who is dehydrated.

3.2.4 Diabetic retinopathy

At 20 years from diagnosis, most people with type 1 diabetes and >60% of those with type 2 diabetes have some degree of retinopathy[19]. While retinopathy might not worsen peri-operatively, pregnancy has been associated

11 Wilson PW, D'Agostino RB, Levy D, *et al.* Prediction of coronary heart disease using risk factor categories. *Circulation* 1998 ;97(18):1837-1847
12 Hollenberg M, Mangano DT, Browner WS, *et al.* Predictors of postoperative myocardial ischemia in patients undergoing noncardiac surgery. The Study of Perioperative Ischemia Research Group. *JAMA* 1992; 268(2):205-209.
13 Risum O, Abdelnoor M, Svennevig JL, *et al*. Diabetes mellitus and morbidity and mortality risks after coronary artery bypass surgery. *Scand J Thorac Cardiovasc Surg* 1996; 30(2):71-75.
14 Rodriguez BL, Lau N, Burchfiel CM, *et al*. Glucose intolerance and 23-year risk of coronary heart disease and total mortality: the Honolulu Heart Program. *Diabetes Care* 1999; 22(8):1262-1265.
15 Aboyans V, Ricco JB, Bartelink M-L EL, *et al*. 2017 ESC Guidelines on the Diagnosis and Treatment of Peripheral Arterial Diseases, in collaboration with the European Society for Vascular Surgery (ESVS). *Eur Heart J* 2018; 39(9):763-816
16 White S, Chadban S. Diabetic Kidney disease in Australia: current burden and future projections. *Nephrology (Carlton)* 2014; 19(8):450-458
17 AIHW Chronic kidney disease web report 2020. https://www.aihw.gov.au/getmedia/0372ad7a-7297-4e7b-a3e4-5681c342ed2f/Chronic-kidney-disease.pdf.aspx?inline=true Accessed 15 May, 2022
18 Gross JL, Mirela J. de Azevedo MJ, Silveiro SP, *et al.* Diabetic Nephropathy: Diagnosis, Prevention, and Treatment. *Diabetes Care* 2005; 28(1):164-176
19 Klein R, Klein BEK. Screening for diabetic retinopathy, revisited. *Am J Ophthalmol*. 2002;134(2):261-263

with significant worsening and rapid deterioration in diabetic retinopathy[20]. Pregnant patients with diabetic retinopathy need to have special consideration peri-operatively given this risk.

3.2.5 Neuropathy

Many different forms of neuropathy are associated with diabetes. The most common is peripheral neuropathy which occurs in about 50% of people with diabetes. Patients may complain of numbness or may be asymptomatic. However, many may have painful neuropathies, which should be addressed prior to elective surgery, if possible, to avoid difficulties post-operatively with pain management, rehabilitation, mobility and recovery.

Also important are the autonomic neuropathies, which can present with decreased autonomic response to hypoglycaemia, orthostatic hypotension, gastroparesis and are often associated with abnormalities of cardiac conduction (prolonged QT). Those impacted often have a long history of diabetes and may have other severe end-organ complications that should be assessed before surgery and monitored throughout the period of hospitalisation. Please refer to section 6.8 on page 28 for more information.

4. DOCUMENT MAP BY DEMARCATION OF ROLES

Table 4 - Roles and responsibilities of clinicians involved in peri-operative management of persons with diabetes

General Practitioners	▪ Primary referral ▪ Screening for at risk individuals ▪ Recognition of suboptimal glycaemia diabetes ▪ Referral to diabetes services ▪ Pre-operative optimisation of glycaemic management ▪ Post-discharge follow up	Surgeon	▪ Recognition of suboptimal glycaemia diabetes, consider referral back to GP prior to booking for surgery. ▪ Liaising with Operating Theatres and Anaesthetist for timing of procedure. ▪ Referral to Diabetes Specialist team when appropriate.
Diabetes Specialist	▪ Pre-operative optimisation ▪ Peri-operative diabetes plan ▪ Management and follow up of coexistent diabetes related complications	Anaesthetist	▪ Immediate peri-operative management. ▪ Immediate post-operative management.

5. PRIMARY REFERRAL PROCESS

The "surgical journey" begins pre-operatively, starting from primary referral to the surgical unit by a general practitioner or other medical practitioner.

5.1 Primary Referral

- A comprehensive referral is recommended identifying issues that will need to be addressed prior to surgery.
- Referral letters should have the following information:
- Duration and type of diabetes.
- Primary medical practitioner responsible for patient's diabetes care (endocrinologist, general physician or general practitioner).

20 Bourry J, Courteville H, Ramdane N, *et al*. Progression of Diabetic Retinopathy and Predictors of Its Development and Progression During Pregnancy in Patients With Type 1 Diabetes: A Report of 499 Pregnancies. *Diabetes Care* 44(1):181-187

- Current treatment for diabetes.
- Complications of diabetes and associated treatment(s). This should include not only micro and macrovascular disease, but any history of hypoglycaemic unawareness or recent hospitalisations for hypoglycaemia or DKA/HHS.
- Other co-morbidities and investigations.
- Laboratory and clinical measurements of relevance, especially:
  - BMI
  - BP
  - Date of most recent cardiac risk assessment (e.g. Exercise stress test, stress echocardiogram, other)
  - HbA1c (within the last 3 months for patients with diabetes, or last 12 months if at risk for diabetes)
  - Latest biochemistry results (electrolytes, glucose and creatinine)

Refer to Appendix A for a sample referral letter.

5.2 Pre-operative Optimisation of Glycaemic Control

5.2.1 Assessment

The primary referrer should consider the need to optimise the patient's glycaemic control prior to surgery. This should include:

- HbA1c assessment.
- Aim for target HbA1c of <75 mmol/mol (9.0%) prior to elective surgery[21].
- Referral to a diabetes specialist for advice if HbA1c ≥75 mmol/mol (9.0%). *If this is not feasible, please see relevant section below.*
- Referral to a diabetes specialist if patient is suspected to have hypoglycaemia unawareness. *If this is not feasible, please see relevant section below.*
- Ensuring usage of blood glucose testing device, by patients who have access to this.
- Encouraging the use of a blood glucose testing device by patients with poor glycaemic control
- Encouraging patients who require medication for diabetes to use a blood glucose testing device in the perioperative period.
- Assessment of the capability of patient / carer to measure fingerprick blood glucose levels (BGLs) including having access to a glucose meter and blood glucose strips (usually via NDSS).
- Review regarding recording of BGLs to facilitate diabetes stabilisation and peri-operative management.

The aim is for the GP or appropriate specialist to have initiated any management changes to optimise care, to avoid potential delays or cancellations prior to surgery.

The peri-operative team may be involved in ongoing management to optimise glycaemic control. The patient should be provided with a written peri-operative plan for their diabetes management (*refer to Appendix G*).

21 Kallio PJ, Nolan J, Olsen AC, Breakwell S, Topp R, Pagel PS. Anesthesia Preoperative Clinic Referral for Elevated Hba1c Reduces Complication Rate in Diabetic Patients Undergoing Total Joint Arthroplasty. *Anesthesiol pain Med*. 2015;5(3):e24376. doi:10.5812/aapm.5(3)2015.24376

5.2.2 HbA1c

- HbA1c is useful for screening for diabetes, and for assessing glycaemic control in patients with diabetes.
- Consider screening for diabetes (see protocol in Figure 2) in all patients referred for surgery.
- A screening HbA1c result ≥48 mmol/mol (≥6.5%) should prompt confirmatory testing for diabetes, such as a fasting plasma glucose or random plasma glucose. These people should be managed in the same way as a 'person with known diabetes'.
- Regardless of HbA1c, any patient with a random BGL >12 mmol/L should be treated as having diabetes for the purposes of peri-operative management.
- HbA1c should not be used in pregnancy for screening.
- All HbA1c results ordered by the peri-operative team should be copied to the patient's GP.

Refer to 'Appendix H: What is HbA1c and its role in management of dysglycaemia?' for background information on HbA1c.

Up to 30% of patients have pre-existing undiagnosed diabetes[22] and hence HbA1c is an important screening tool.

HbA1c has Medicare subsidy approval in Australia as a diagnostic test for people who are at high risk for diabetes, but it can only be requested once in a 12-month period to be covered by Medicare. In people with known diabetes, HbA1c should ideally be performed every 3-4 months to monitor glycaemic control. It is Medicare subsidised for 4 measurements in a 12-month period. There are no restrictions in New Zealand on HbA1c testing frequency, other than by good clinical practice.

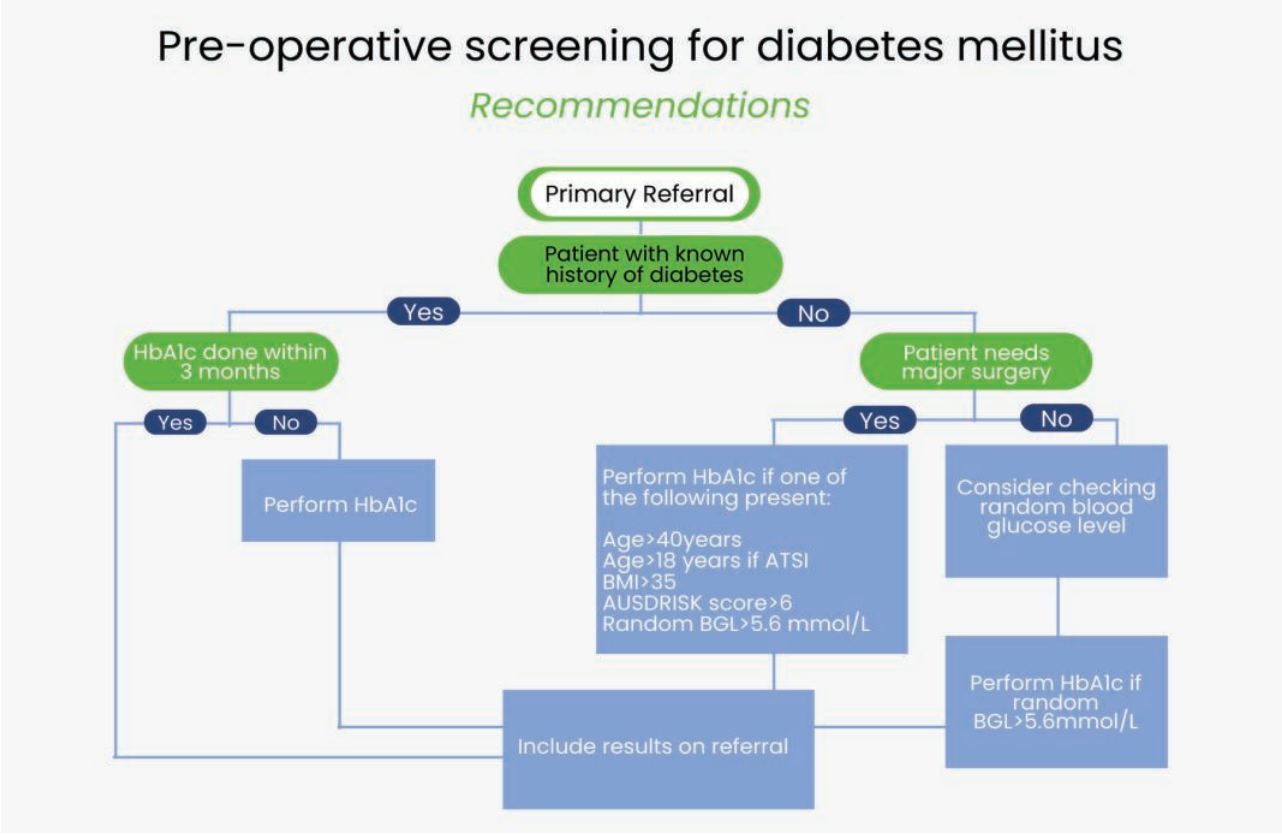


Figure 2 - Recommendations for the pre-operative screening for diabetes mellitus

22 Diabetes in Australia. https://www.diabetesaustralia.com.au/diabetes-in-australia burden-of-disease-its-time-for-more-action-report.pdf. Accessed 15 May 2022

We propose screening patients based on the algorithm in Figure 2- Recommendations for the pre-operative screening for Diabetes Mellitus.

We recommend HbA1c to be done for people without known history of diabetes who are scheduled to undergo major surgery if they fit any of the following criteria:

- > 40 years of age, OR
- >18 years of age if they have Aboriginal or Torres Strait Islander heritage/ ethnicity, OR
- Considered to have intermediate or high risk of diabetes on the AUSDRISK calculator (*see Appendix B – AUSDRISK calculator*), OR
- BMI >35 kg/m^2, OR
- Have a random BGL > 5.6 mmol/L[23].

In areas where the population at risk of diabetes is expected to be high, it is reasonable to screen all undergoing major surgery.

Where the use of the AUSDRISK calculator may not be feasible, a BMI >35 kg/m^2 can be used as a practical alternative.

For minor surgery, a random BGL at the time of screening for electrolytes or other blood tests should be considered.

HbA1c is not recommended for screening for gestational diabetes. An oral glucose tolerance test is the recognised screening test for gestational diabetes. Women with gestational diabetes should have self-blood glucose monitoring results and may have had an HbA1c as part of their antenatal management. However, pregnant women who have known diabetes prior to pregnancy should have HbA1c done as part of the pre-surgical work up, as for all people with diabetes.

If an HbA1c was performed by the pre-admission unit or surgical unit, the results should be forwarded to the GP involved in care and a letter with the recommended management should be sent to the GP. A sample letter to the GP is provided *(refer to Appendix D – Sample Letter to GP for Patients with Elevated HbA1c)*.

If the HbA1c is >48 mmol/mol (6.5%) for a patient without prior known diabetes, the patient should be treated as a person with known diabetes. Confirmatory testing such as a fasting glucose or random plasma glucose should be performed when possible post-operatively by the patient's general practitioner.

Regardless of the HbA1c, if a random BGL is >12 mmol/L, unless the patient is unwell, a confirmatory test of glycaemia needs to be performed and the patient needs to be managed based on the combined results. In such cases, pre-admission treatment is not required until glycaemic status is clarified. However, if the elevated blood glucose level is detected in the peri-operative period active management is indicated, as for a person with known diabetes.

Where possible the primary referrer (usually the GP) should include HbA1c results for the past 6-12 months in their referral but the most recent value within three months is the most critical.

5.2.3 Preoperative Optimisation of HbA1c >75 mmol/mol

For people with known diabetes and a high HbA1c ≥75 mmol/mol (≥9.0%), elective surgery should be delayed due to evidence of poorer outcomes[24].

23 Bowen ME, Xuan L, Lingvay I, Halm EA. Random Blood Glucose: A Robust Risk Factor For Type 2 Diabetes. *J Clin Endocrinol Metab* 2015; 100(4):1503-1510

24 Dhatairiya K, Flanagan D, Hilton L, *et al.* Management of adults with diabetes undergoing surgery and elective procedures: improving standards Summary. 2011;(April):40

The exact approach to attain better glycaemic control is beyond the scope of this guideline but is likely to require modification of their existing diabetes therapy by additionally incorporating insulin or other non-insulin interventions, if rapid improvement in control is needed. These other interventions would include up-titration of current oral medications and addition of other anti-hyperglycaemic medications, which may include insulin, and these need to be implemented for at least a month to demonstrate effectiveness and safety. The period needed to improve glycaemic control may result in delay of surgery of >3 months.

In more urgent surgery settings, the balance of risks between poorer peri-operative outcomes and delaying surgery will need to be considered. If feasible, a delay of 1-2 weeks to improve glycaemic control (using strategies discussed above) may be adequate. Improved glycaemic control in such circumstances would be demonstrated as a downward trend in measured BGLs, rather than a reduction in HbA1c.

5.2.4 Insulin Sensitivity Factor (ISF)

The insulin sensitivity factor (ISF) is an approximate amount by which one unit of insulin will lower the BGL (in mmol/L). It may be referred to as 'correction factor'. For example, if a person's BGL falls from 12 mmol/L to 10 mmol/L over ~3-4 hours after administration of 1 unit of insulin, then their ISF is 2. A target BGL of 6.0 – 8.0 mmol/L is usually used in calculating the correction dose for people with type 1 diabetes managed with MDI. The lower the ISF, the higher the bolus to be delivered and vice versa.

Although ISF is a useful concept, it is not a precise measure. It may be influenced by factors such as time of day, level of blood glucose, physical activity etc. However, it is helpful to estimate a correction dose of subcutaneous rapid acting insulin.

Many patients with type 1 diabetes would be familiar with the use of ISF/correction factor. A patient with type 1 diabetes should have their ISF assessed and documented prior to surgery.

For insulin pump users, the ISF will already be programmed into their insulin pump. Discuss the pump settings with the patient, including the timing of the most recent review by their specialist/diabetes educator. Any suspicion that the pump settings are incorrect due to frequent hypoglycaemia or uncontrolled hyperglycaemia, warrants referral to their specialist for optimisation prior to surgery.

One way of estimating an ***initial ISF*** for insulin treated patients is by using the equation ISF = 100/total daily insulin dose.

E.g. [1] If a patient is on a total of 50 units of insulin per day the ISF = 2 (100/50)

1 unit of insulin is anticipated to lower the BGL by 2 mmol/L.

The ISF is then used to estimate a **correction dose** of subcutaneous rapid acting insulin.

[2] The patient has a target BGL of 8 mmol/L. If the BGL is 14 mmol/L and the ISF is 2, giving 3 units of rapid acting insulin is expected to correct the BGL to 8 mmol/L over the next 3-4 hours.

Written instructions should be provided to the patient. An example for the above patient follows:

Table 5 - Example of estimating correction dose of subcutaneous rapid acting insulin

Patient name/details:	
Your insulin sensitivity factor is: 2 1 unit of insulin is expected to lower your blood glucose by 2 mmol/L over the next 4 hours. Your target BGL is: 8 mmol/L	
When your BGL is:	Give (name of rapid acting insulin)
12 mmol/L	2 units

14 mmol/L	3 units
16 mmol/L	4 units
18 mmol/L	5 units
20 mmol/L	6 units
>20 mmol/L	8 units *(if >20 mmol/L more than once, please inform your specialist, or surgical team)*

If a correction bolus of insulin results in hypoglycaemia, the ISF needs to be 'weakened' e.g. change from ISF of 2 to ISF of 3. This would hopefully prevent hypoglycaemia with subsequent correction boluses.

Conversely if a correction bolus fails to adequately correct the BGL, the ISF would needs to be 'strengthened' e.g. change from ISF 4 to ISF 3.

NB: Due to the pharmacokinetic properties of rapid acting insulin, the correction insulin dose will take more than 2 hours to have its maximum effect. Do not give further correctional insulin within 3 hours.

5.2.5 Hypoglycaemia Unawareness

Hypoglycaemic symptoms can be classified as *neurogenic* or *neuroglycopaenic*.

Neurogenic symptoms are those largely caused by the sympathetic nervous system rather than from an adrenomedullary activation. These include tremor, palpitations, anxiety/arousal, sweating or hunger.

Neuroglycopaenic symptoms may include cognitive impairment, behavioural changes, psychomotor abnormalities and in severe cases, coma and seizures.

Neurogenic symptoms tend to occur at higher BGL and thus occur before the neuroglycopaenic symptoms.

A history of asymptomatic hypoglycaemia (BGL <4.0 mmol/L) with no typical symptoms of hypoglycaemia should raise suspicion of hypoglycaemia unawareness. A reduction in medication(s) and raising the BGL target in consultation with the primary diabetes caregiver may be advisable.

6. PRE-OPERATIVE MANAGEMENT

6.1 Fasting

A sample patient hand-out is provided in *(refer to Appendix F – Sample Pre-surgery Instructions for People with Diabetes)* and covers the following section.

Fasting for solid foods may start at midnight for a morning procedure. The person should be advised to have water until approximately 2 hours prior to surgery and to treat hypoglycaemia <4 mmol/L with clear apple juice.

6.1.1 Oral fluids

- Dedicated instruction sheets should be provided to patients.
- Only water should be used for hydration. *Clear* apple juice can be used for management of hypoglycaemia.

People with diabetes should be provided with a dedicated instruction sheet for diet and fluid restrictions in the period just prior to surgery. For management of hypoglycaemia clear apple juice alone should be used.

Enhanced Recovery After Surgery (ERAS) is a multimodal perioperative care pathway implemented by certain

surgical services with an aim to achieve early recovery for patients undergoing major surgery. Where ERAS protocols incorporate pre-operative carbohydrate loading/withholding the carbohydrate load should be considered. Alternatively, appropriate adjustments must be made to the patient's diabetes management to cover the carbohydrate load.

6.1.2 Non-insulin anti-hyperglycaemic medications

- SGLT2 inhibitors should be withheld for two days prior to surgery and the day of surgery. The exception is for minor surgery patients (including Day Stay) who only need to omit their SGLT2i agents on the morning of their procedure.
- All other anti-hyperglycaemic medications should be continued up to and including the night before surgery.
- All non-insulin anti-hyperglycaemic medications should be withheld on the day of surgery.

Although there are non-insulin medications that may be safe for use through the peri-operative period, it is recommended that all non-insulin diabetes medications should be omitted on the day of surgery, including non-insulin injectables for diabetes such as GLP-1 agonists.

The new class of oral anti-hyperglycaemic medication, the SGLT-2 inhibitors, may cause diabetic ketoacidosis which can be euglycaemic (euDKA)[25,26]. In patients who use this medication, the following approach is advised peri-operatively[27].

For surgery and procedures requiring one or more days in hospital, and/or requiring 'bowel preparation' including colonoscopy SGLT2i should be withheld two days prior to surgery and the day of surgery. Increasing the doses of other glucose lowering agents used by the patient should be considered while SGLT2i are withheld.

- For day-stay procedures (including gastroscopy), SGLT2i can be withheld just on the day of the procedure. However, duration of fasting before and after the procedure should be minimised.
- In patients undergoing nonurgent surgery with elevated HbA1c > 9%, glycaemic stability should be reviewed, and postponement of surgery should be considered if they are unwell on the day of surgery due to increased risk of DKA ***(refer to Appendix L for detailed management advice in the ADS-ANZCA Alert).***
- Both blood glucose and blood ketone levels should be checked in the peri-operative period if the patient is fasting, is unwell (common symptoms being nausea, vomiting, abdominal pain or general malaise) or has limited oral intake and has been on an SGLT2i in the week prior to surgery.
- Fingerprick blood ketones should be done on all patients on the day of surgery.
- Adequate hydration should be maintained in fasting patients.
- Patients with blood ketone level >1 mmol/L should have an urgent arterial blood gas (ABG) or venous blood gas (VBG) sample to measure the Base Excess and the treating team, local endocrinologists/physicians and anaesthetist should be notified[23].

25 Fleming N, Hamblin PS, Story D, Ekinci EI. Evolving Evidence of DKA With SGLT2i Use. *J Clin Endocrinol Metab* 2020; 105(8):2475–2486

26 Peters AL, Buschur EO, Buse JB, *et al*. Euglycemic Diabetic Ketoacidosis: A Potential Complication of Treatment With Sodium-Glucose Cotransporter 2 Inhibition. *Diabetes Care* 2015; 38(9):1687-1693

27 Australian Diabetes Society 2022 ALERT: Periprocedural Diabetic Ketoacidosis (DKA) with SGLT2 Inhibitor Use in People with Diabetes. https://diabetessociety.com.au/downloads/20220209%202021%20ADS_DKA_SGLT2i_Alert_highlighted%20changes_Jan%2022%20.pdf

- A diagnosis of DKA is made if base excess is <–5 mmol/L with ketones >1.0 mmol/L and care should be escalated urgently through discussion with endocrinologists/physicians and critical care teams as appropriate within local protocols.
- In patients who have not ceased taking their SGLT2i medications for a sufficient period of time preoperatively and whose surgery cannot be deferred, a more careful approach to monitoring of blood ketones will be needed for at least 2-3 days post-operatively (especially if the patient becomes unwell).
- SGLT2i can be recommenced when the patient is eating and drinking reliably, ideally on discharge. Written advice should be provided to patients to seek medical review if unwell in the week following surgery.

6.1.3 Insulin regimen (except insulin pumps)

- Usual insulin regimen should be continued up to and including the night before surgery EXCEPT where bowel preparation is required (section 6.9).

People with diabetes should be provided with clear written instructions for management of their insulin regimen at home prior to hospital.

Continue all basal insulin at usual dose and time. Exception: Reduce basal insulin dose by 20% if recent overnight hypoglycaemia.

If pre-mixed insulin, reduce usual morning dose by 50%. Omit any lunchtime dose.

If co-formulated insulin and morning procedure, delay any morning dose till lunchtime (if eating) or evening (if not usually on evening co-formulated insulin). If usually lunchtime co-formulated insulin and morning procedure, continue usual lunchtime dose if eating lunch or delay till evening meal.

If co-formulated insulin and afternoon procedure, reduce any morning dose by 50%. Omit any lunchtime dose. Resume usual evening dose if eating. If not eating, *(refer to Appendix K)*.

Blood glucose level (BGL) should be monitored from the time the person with diabetes is awake on the day of surgery and every 1-2 hours after, until they arrive at hospital. The BGL should also be checked on admission. Target BGL range perioperatively is 5-10mmol/L.

For those undergoing bowel preparation, please refer to section 6.9 on *Bowel Preparation for Colonoscopy, Barium Enema, Bowel Surgery*.

For people managed on continuous subcutaneous insulin infusion, please refer to section 6.5 on *Insulin Pumps*.

[See Appendix I – Types of Insulin and Appendix K – Guide to preoperative insulin management respectively for more information].

6.1.4 Driving

- Patients are advised to not drive on the morning of surgery.
- As is routinely advised, a person should not drive for 24 hours following an anaesthetic.

Due to the risk of hypoglycaemia when fasting prior to surgery, we recommend that people with diabetes do not drive themselves to the hospital on the day of the procedure. They should also not drive for 24 hours after sedation or anaesthetic.

6.2 Intravenous fluids

- Isotonic solution such as 0.9% saline, Hartmann's or Plasmalyte should be used for hydration.

- Glucose-containing fluid should be used only for treatment of hypoglycaemia or for people with 'starvation' ketosis/ketoacidosis related to type 1 diabetes mellitus or SGLT2 inhibitors.
- Sodium and potassium should be monitored at least daily if patient is on an insulin-glucose infusion.

Glucose-containing fluids should be avoided except to treat hypoglycaemia. 0.9% Saline, Hartmann's or Plasmalyte solutions are considered appropriate for general hydration of the patient. When the patient is on an intravenous insulin-glucose infusion, potassium should be monitored and replaced as required.

Any individual with ketosis (blood ketones >1.0 mmol/L in presence of normoglycaemia, and on a variable rate insulin infusion (VRII), should be given glucose-containing fluids to help clear the ketones more rapidly.

If glucose containing fluid is used for treatment of hypoglycaemia or in conjunction with a VRII, it must be noted that these hypotonic solutions predispose to hyponatraemia[28]. Up to 30% incidence of hyponatraemia has been reported in individuals managed with 5% glucose infusion and VRII. This has also been associated with significant morbidity including hyponatraemic encephalopathy. As a result of this, guidelines in the UK[29] and US[30] suggest using 0.45% saline with 5% glucose and 0.15-0.30% KCl.

Due to the lack of general availability of such solutions in Australia, 5% glucose can be used, but it is recommended that sodium and potassium monitoring should be performed at least daily when a VRII is used for more than 24 hours.

Patients with a sodium level trending towards the lower end of the normal range should be started on isotonic saline concurrently.

25-50 mLs of 50% glucose via syringe pump can be used as an alternative for treatment of hypoglycaemia.

6.3 Glycaemic Monitoring

- Hourly BGL monitoring is recommended except for people with type 2 diabetes with pre-operative HbA1c <53 mmol/mol (7%) managed with metformin alone where 2 hourly BGL monitoring is adequate.

Regular BGL monitoring is important throughout the peri-operative period. The capillary BGL should be checked hourly when fasting while in hospital. To facilitate this, the patient should be encouraged to bring their glucose meters with them when being admitted to the hospital.

An exception to the above is for patients who have type 2 diabetes on diet alone or metformin alone with acceptable pre-operative glycaemic control (HbA1c less than 53 mmol/mol (7.0%)). In such patients the BGL can be monitored 2 hourly except if they trend off-target, when they should be checked more frequently and managed accordingly.

6.4 Blood Glucose Level Target

- Target blood glucose level of 5-10 mmol/L in general is recommended; exceptions are listed below.

The general recommendation for BGL target peri-operatively is 7.5±2.5 mmol/L (5-10 mmol/L with the optimal target being in the middle of the range-8 mmol/L). The exceptions to this target would be:

28 Moritz ML, Ayus JC. Maintenance Intravenous Fluids in Acutely Ill Patients. *N Engl J Med* 2015; 373(14):1350-1360

29 UK Guideline for Perioperative Care for People with Diabetes Mellitus Undergoing Elective and Emergency Surgery https://abcd.care/sites/abcd.care/files/site_uploads/CPOC_Diabetes_Surgery_Guideline_March_2021.pdf

30 Joshi GP, Chung F, Vann MA, *et al.* Society for ambulatory anesthesia consensus statement on perioperative blood glucose management in diabetic patients undergoing ambulatory surgery. *Anesth Analg*. 2010; 111(6):1378-1387

- Tighter target (5.0±1.0 mmol/L): Pregnancy
- Higher target (10.0±2.5 mmol/L):
  - Emergency surgery in setting of previous poor glycaemic control
  - Known hypoglycaemia unawareness
  - Known prolonged QT interval or autonomic neuropathy
  - Elderly patients (>75 yrs)

6.5 Insulin Pumps

- When being admitted, individuals using insulin pumps should bring with them:
  - a printed record of their latest pump settings
  - a record of recent glucose levels from a pump download and,
  - flash or continuous glucose monitoring device reports, where available.
- The line and infusion set should be changed 24 hours before surgery. The insertion site should be moved to a site distant from the site of planned surgery. The person with diabetes should confirm that the pump is working properly at the new site.
- Teflon cannulas MUST be used for the pump and metal cannulas must be avoided.
- Persons with diabetes should also monitor fingerprick BGLs and record them if nursing staff are unable to do so.
- Basal insulin infusion on pump should be continued at pre-set rates throughout surgery.
- A temporary basal rate of 80% (i.e. 20% reduction from baseline) should be set if tight glycaemic control is evident or if:
  - There is evidence of recent hypoglycaemia
  - HbA1c is <48 mmol/mol (6.5%) or
  - Fasting BGL has been <5 mmol/L in recent weeks

A decision needs to be made pre-operatively as to whether it is safe for insulin pump therapy to be used during the peri-operative period. If there is insufficient support and/or experience locally in managing insulin pump therapy, peri-operative diabetes management may need to be done using intravenous insulin-glucose infusion. It is critical that insulin pump therapy is not suspended without alternative delivery of insulin.

Prior to surgery, persons with diabetes using an insulin pump should perform a download of their pump data including the settings (or get the help of their diabetes educators or specialist to do so). A copy of this should be brought on admission to hospital.

Once fasting, the pump's usual basal infusion rates should be continued. If the person's glycaemic control is tight, evidenced by frequent hypoglycaemia, HbA1c <48 mmol/mol (6.5%) or a fasting BGL of <5 mmol/L in recent weeks, then a temporary basal rate of 80% (a reduction of 20% from baseline) is recommended.

Line and set should be changed 24 hours before surgery. The insertion site should be moved to a site distant from the site of planned surgery. The new site should be checked with the surgeon to ensure that this is acceptable to them. The person with diabetes should confirm that the pump is working properly at the new site.

If BGLs are out of target range >2 hours prior to surgery, apple juice for treatment of hypoglycaemia or a correction bolus given via the pump for treatment of hyperglycaemia, can be used.

If BGLs are out of target range <2 hours prior to surgery, glucose infusion for treatment of hypoglycaemia or additional insulin for correction of hyperglycaemia should be provided intravenously.

For intra-operative management, please see section 7.4.3 Insulin Pumps on page 33.

6.6 Pre-Admission Hyperglycaemia

Prior to admission, hyperglycaemia should be treated when the level reaches >12 mmol/L. The treatment should be more conservative than the patient's usual management to avoid subsequent hypoglycaemia.

6.6.1 Type 1 Diabetes

People with type 1 diabetes should be aware of their insulin sensitivity factor (ISF). Corrections for hyperglycaemia should be based on their ISF. Please refer to 5.2.4 *Insulin Sensitivity Factor (ISF)* on page 21 for more information. Written instructions should also be provided to guide patients.

6.6.2 Type 2 and other forms of Diabetes

Patients with type 2 diabetes should be provided instructions for managing hyperglycaemia by their treating specialist or general practitioner. If there are no prior instructions the following weight-based recommendation can be used for management of hyperglycaemia.

Subcutaneous rapid-acting insulin can be administered with the dosing determined by the patient's body weight:

- If >100 kg, give 6 units every 3 hours until BGL is <12 mmol/L.
- If 55 – 100 kg, give 4 units every 3 hours until BGL is <12 mmol/L.
- If <55kg, give 2 units every 4 hours until BGL is <12 mmol/L.

6.7 Hypoglycaemia

- Hypoglycaemia (BGL <4.0 mmol/L) must be avoided.
- Treatment begins when BGL falls to <5.0 mmol/L to avoid hypoglycaemia.
- 5% glucose, or 50% glucose can be used for management of hypoglycaemia (*see text below for recommended protocol).*

Hypoglycaemia (BGL <4.0 mmol/L) has been associated with increased mortality in patients admitted to hospital and may explain an increase in mortality in ICU patients with tighter glycaemic control [31]. The best strategy for management of peri-operative hypoglycaemia is prevention.

If a patient is commenced on a VRII, the glycaemic trend should be noted. If the BGL is found to be falling steadily although it is still within the target range, the insulin infusion rate should be decreased based on the trend or a 5% glucose infusion should be started prior to the BGL decreasing below 5.0 mmol/L.

Patients not on an insulin infusion but with a glycaemic trend that is dropping towards 5.0 mmol/L should receive prompt attention with consideration of starting a 5% or more concentrated glucose infusion as for patients with BGL <5.0 mmol/L (*see below*).

Patients with BGL <5.0 mmol/L should always be treated. If the patient is fasting or is in the immediate peri-operative period, small amounts of 5 g of glucose (10 ml of 50% glucose or 100 ml of 5% glucose) can be provided intravenously. Patient's BGL should be remeasured every 15 minutes until BGL is within range. The BGL should then be monitored hourly as per protocol. For those requiring ongoing infusion, the following recommendations are provided:

31 The NICE-SUGAR Study Investigators. Intensive versus Conventional Glucose Control in Critically Ill Patients. *N Engl J Med* 2009; 360:1283-1297

5. Infuse a bolus of 5 g of glucose (10 mLs of 50% glucose or 100 mLs of 5% glucose) followed by an infusion of 5 g of glucose/hour (10 mLs of 50% glucose/hour or 100 mLs of 5% glucose/hour), and
6. Measure the BGL after 15 minutes and adjust infusion rate to maintain BGL 5-10 mmol/L. As a guide, if the BGL remains stable but in the lower end of the range, an increase in infusion rate by 10-20% is reasonable. If the BGL is still falling despite the glucose infusion, a greater increment dependent on the absolute BGL value should be considered.

6.8 Management of patients with prolonged QT interval

- Prolonged QT interval is more common in patients with autonomic neuropathy and diabetes.
- QCTc >500ms is associated with **increased risk of Torsades de Pointes, and death.**
- Many common drugs are associated with prolongation of QT and should be avoided e.g. droperidol and ondansetron.

Prolonged QT interval is more common in people with diabetes of long duration and those with known autonomic neuropathy. All persons with diabetes should have a pre-operative 12 lead ECG.

Management of individuals with prolonged QT interval should be discussed with a cardiologist, if possible, especially if it is severely prolonged, with QTc >460 ms in men and >480 ms in women. QTc >500 ms is associated with increased risk of Torsades de Pointes.

Peri-operatively, drugs known to prolong the QT interval should be avoided. Hypoglycaemia may also prolong the QT interval. Potassium, magnesium and calcium levels should be checked, and corrected if abnormal. Table 6 lists common drugs that are associated with QT prolongation.

Table 6 - Drugs associated with QT prolongation

Antipsychotics	**Type IA antiarrhythmics**	**Type IC antiarrhythmics**	**Class III antiarrhythmics**
Chlorpromazine Haloperidol Droperidol Quetiapine Olanzapine Amisulpride	Quinidine Procainamide	Flecainide	Sotalol Amiodarone
Tricyclic antidepressants	**Non-tricyclic Antidepressants**	**Antihistamines**	**Other**
Amitriptyline Doxepin Imipramine Nortriptyline Desipramine	Mianserin Citalopram Escitalopram Venlafaxine Bupropion Moclobemide	Diphenhydramine Loratidine	Chloroquine Hydroxychloroquine Quinine Ondansetron Macrolides ▪ Erythromycin ▪ Clarithromycin

6.9. Bowel Preparation for Colonoscopy, Barium Enema, Bowel Surgery

6.9.1 Introduction

All people with diabetes undergoing bowel preparation outside of the hospital should be provided with clear instructions. A sample information sheet is provided in *(Appendix F – Sample Instructions for Bowel Preparation).*

- In line with other surgical procedures, all non-insulin anti-hyperglycaemic agents including injectables should be withheld on the morning of the procedure. SGLT2i should be withheld two days prior to procedure and on the day of procedure.

6.9.2 BGL monitoring

- BGL should be checked 2 hourly during the day from rising until bedtime.

People with diabetes on insulin should be mindful of the changes to their insulin regimen and be informed to check their BGL regularly, especially if they have type 1 diabetes. BGL should be tested 2 hourly during the day from rising until bedtime if using insulin and at least 4-6 hourly if person is not on insulin but has capability to test BGL.

6.9.3 BGL target

- BGL should be maintained within a target of 7.5±2.5 mmol/L (see section 6.4, Blood Glucose Level Target).
- Clear apple juice and sugar-containing cordial (not artificially sweetened) or jelly (**not red**, **blue** or **orange** in colour) can be used for treatment of hypoglycaemia.
- Written instructions for rapid acting insulin to guide correction for hyperglycaemia should be provided where required.

To help with maintaining the BGL, clear apple juice, sugar-containing cordial (not artificially sweetened) or jelly (**not red, blue** or **orange** in colour) should be readily available for use to prevent and manage hypoglycaemia. This is especially important for patients on rapid-acting or pre-mixed insulin, where the rapid-acting component can cause hypoglycaemia.

In general, BGL <5 mmol/L should be treated with ½ cup of a sugar-containing liquid (e.g. clear apple juice). The BGL should be rechecked in 10-15 minutes, and the process repeated if the BGL remains low.

For individuals with BGLs that are trending towards the higher end of the target range, consumption of sugar-containing fluids should be limited and replaced with **diet** cordial or clear broths.

6.9.4 Insulin regimen: On the day of Bowel Preparation

Changes are recommended during bowel preparation for patients on insulin. The evening insulin dose should be lowered to avoid hypoglycaemia during "bowel clean-out." Refer to ***Appendix E*** for guidance on diabetes medication adjustment and to ***Appendix F*** for sample patient instructions for bowel preparation for patients with diabetes.

6.9.5 Hyperglycaemia

For patients whose usual diabetes management includes rapid acting insulin, a BGL >12 mmol/L should be corrected. Written instructions should be provided, with recommendations for correction dosing (***as per table example page 34***). For safety, the patient should be advised to not have two correction doses within 3 hours of each other.

7. INTRA-OPERATIVE MANAGEMENT

7.1 Dexamethasone Use

- Dexamethasone is useful for *prevention* but not treatment of nausea and vomiting.
- BGL should be monitored closely if dexamethasone is used. Use of dexamethasone should be highlighted.

Intra-operative dexamethasone is frequently used as a prophylactic anti-emetic. Its use is associated with glucocorticoid-induced hyperglycaemia peri-operatively and requires more frequent post-operative BGL measurement. Communication about its administration is important to facilitate assessment for postoperative hyperglycaemia.

Where possible, it is recommended to use other anti-emetics.

7.2 Glycaemic Monitoring

Hourly BGL monitoring is recommended except for people with type 2 diabetes with pre-operative HbA1c < 53 mmol/mol (7.0%) who are managed with metformin alone, where 2 hourly BGL monitoring is adequate.

In theatre, the BGLs should be checked hourly except for people with type 2 diabetes with pre-operative HbA1c < 53 mmol/mol (7.0%) managed with metformin alone. In such instances 2 hourly BGL monitoring is adequate. Should the BGLs trend towards becoming off target, the monitoring frequency should also be increased, and appropriate management undertaken.

7.3 Hyperglycaemia Management

- Consider treating hyperglycaemia when BGL >10 mmol/L.
- Consider commencing VRII if BGL >12 mmol/L consistently for more than an hour despite a bolus dose of rapid acting insulin or if it is rising rapidly.
- Consider commencing VRII when BGL >15 mmol/L.
- Perform a blood gas and fingerstick ketones should be measured when BGL >15 mmol/L to check for ketoacidosis.
- Individuals on insulin infusion should be managed as per section 7.4 Variable Rate Insulin Infusion.

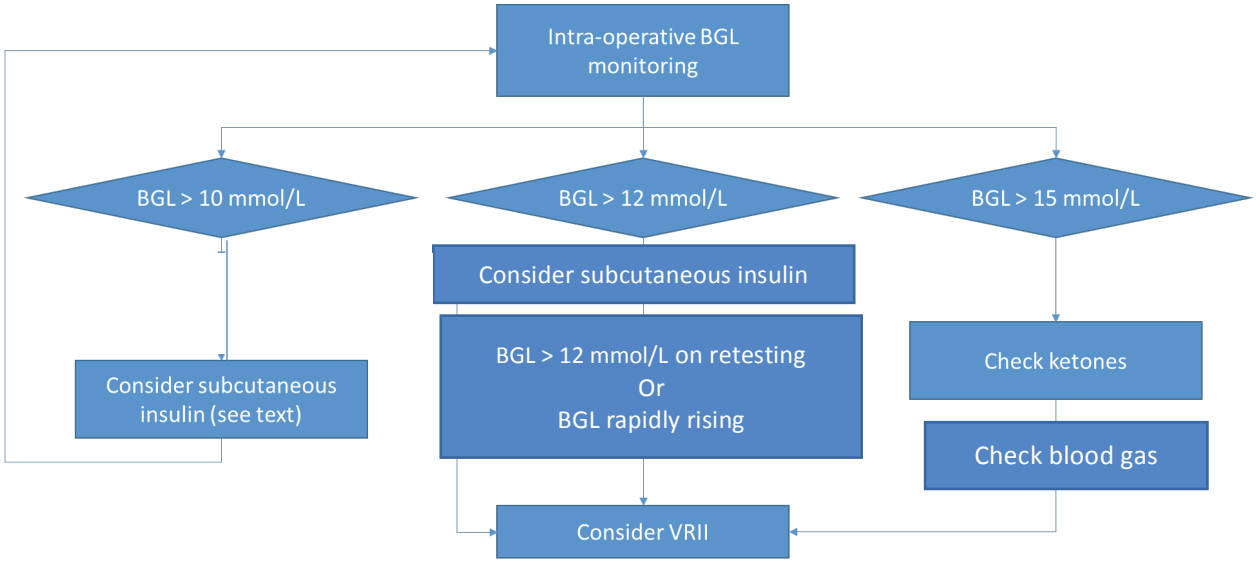


Figure 3 - Suggested algorithm for intra-operative hyperglycaemia. For individuals on a subcutaneous insulin pump, any rapid increase in BGL should prompt consideration for VRII and cessation of the pump intra-operatively.

7.3.1 Type 1 Diabetes

If the patient is on VRII, please refer to *7.4 Variable Rate Insulin Infusion* on page 32. The insulin rate should be adjusted to keep the hourly BGL within the target range.

Patients with type 1 diabetes should have a recorded ISF. Please refer to *5.2.4 Insulin Sensitivity Factor (ISF)* on page 21 for more information.

If the BGL is >12 mmol/L:

- administer rapid-acting insulin by subcutaneous injection, e.g. Novorapid (see ISF section page 21); OR
- consider VRII if the BGL is rising rapidly or >12 mmol/L on repeat testing. See section 7.4 Variable Rate Insulin Infusion on page 32.

If BGL is rapidly rising in patients on subcutaneous insulin pump therapy, there may be a problem with insulin delivery. The pump settings should not be adjusted intra-operatively. Commence VRII and adjust according to monitored BGLs. The diabetes team should be asked to review the insulin pump post-procedure.

If BGL is >15 mmol/L a blood gas should be performed, and blood (or urine) ketones should be measured if possible, to check for possible ketoacidosis and commencement of VRII.

7.3.2 Type 2 and other types of diabetes

If there are no pre-existing instructions from the person's usual diabetes physician, the following weight-based recommendation for correction insulin doses can be used. Subcutaneous insulin therapy should be given when capillary BGL rises above 12 mmol/L. Consider a variable rate insulin infusion if the BGL is rising rapidly or >15 mmol/L. See section 7.4 Variable Rate Insulin Infusion on page 32.

Subcutaneous rapid-acting insulin correction doses with the dosing determined by the patient's body weight:

- If >100 kg, give 6 units every 3 hours until BGL is <10 mmol/L.
- If 55 – 100 kg, give 4 units every 3 hours until BGL is <10 mmol/L.
- If <55kg, give 2 units every 4 hours until BGL is <10 mmol/L.

7.4 Variable Rate Insulin Infusion

An intravenous insulin infusion is prepared by using prefilled syringes or by making up a 50 mL syringe with 50 units of Actrapid® with 49.5 mL of 0.9% sodium chloride solution.

Local protocols are usually available and should be followed.

7.4.1 VRII algorithm

For individuals not previously on insulin, start insulin at (0.02 unit/kg/hour x Body weight).

Blood glucose should be monitored hourly and the rate adjusted as appropriate.

For insulin treated individuals, the initial insulin infusion hourly rate can be calculated as follows;

Initial infusion rate (units/hr) = Total daily dose insulin (TDD)/24.

Table 7 - Initial insulin infusion dose calculation

Initial Insulin Infusion Dose	
For patients previously on insulin Total insulin used/day (unit/day) = total daily dose (TDD) insulin	Initial Dose (unit/hour) = (TDD ÷ 24 hours)
For patients not previously on insulin	Initial dose (unit/hour) = 0.02 x Body weight in kg

The following is a sample algorithm for on-going insulin infusion rate adjustment can be used (adapted and modified from NSW ACI algorithm). This particular algorithm considers the current glycaemia as well as the glycaemic trend based on the previous BGL reading. Local protocols may vary, and should be used where available instead of this sample algorithm. Please note that insulin dose adjustments and initial insulin dosing based on these algorithms are not meant to replace sound medical judgment.

For the algorithm, please refer *to Table 8:* Algorithm for Insulin rate adjustments and titration on page 34. This table considers the glycaemic trend (not just the current BGL) and target BGL range of 7.5-10 mmol/L to avoid hypoglycaemia, while maintaining BGL below 10 mmol/L. The BGL ranges are not evenly spaced in the algorithm to allow smaller changes to the infusion rate when the BGL is close to the target range. The algorithm assumes that BGL is checked hourly during insulin dose titration.

All unexplained hypoglycaemia and hyperglycaemia should be investigated and causative factors corrected.

7.4.2 Cessation of VRII

VRII is usually not ceased in the first 24 hours if it has been initiated intra-operatively.

For more details regarding cessation, please refer to *7.7.2 Cessation of VRII* on page 36.

7.4.3 Insulin Pumps

For management of the insulin pump pre-operatively, please refer to section 6.5 Insulin Pumps on page 26.

While we recommend continuing the insulin pump in general, it should be discontinued when VRII has to be initiated during surgery. This is to reduce the number of variables and potential issues arising from multiple concurrent sources of insulin while the BGL is unstable in the intra-operative period. A malfunctioning insulin pump during surgery cannot be reviewed until the postoperative period.

As for all people with type 1 diabetes, BGL should be monitored hourly intra-operatively.

Table 8 - Algorithm for Insulin rate adjustments and titration. Target BGL Range 5-10 mmol/L

BGL (mmol/L)	BGL trend	Insulin Infusion Rate Adjustment
<5.0	**Stop** the insulin infusion	▪ Refer to the clinical emergency response system (CERS) protocol. ▪ Follow the Management of Hypoglycaemia protocol. ▪ If the patient is NBM, seek urgent medical review for IV order of Glucose or Glucagon when no IV access. ▪ Check BGLs every 15 minutes until >5 mmol/L, then hourly for at least next 6 hours. ▪ Once BGL >10 mmol/L recommence insulin infusion as per protocol.
5.1 – 7.9 **IF**	↓ BGL Falling *** Compared to the previous Reading*	↓ Decrease Rate by 3 units/hour (3mL/hr) **OR** Cease Infusion if running at ≤ 3 unit/hour **IN TYPE 1 DIABETES** – *don't cease for more than 1 hour; run at low rate if possible*
IF	BGL Stable ** [i.e. ± 0.5 mmol/L]	↓ Decrease Rate by 1 unit/hour **OR** Cease Infusion if running at ≤ 1 unit/hour **IN TYPE 1 DIABETES** – *don't cease for more than 1 hour; run at low rate if possible*
IF	↑ BGL Rising	**No Change**
8.0 – 9.4 **IF**	↓ BGL Falling	↓ Decrease Rate by 1 unit/hour (1 mL/hr) **OR** Cease Infusion if running at ≤ 1 unit/hour **IN TYPE 1 DIABETES** – *don't cease for more than 1 hour; run at low rate if possible*
IF	BGL Stable ** [ie ± 1.0 mmol/L]	**No Change**
IF	↑ BGL Rising**	↑ Increase Rate by 1 unit/hour (1 mL/hr)
9.5 - 10.9 **IF**	↓ BGL Falling**	↓ Decrease rate by 1 unit/hour (1 mL/hr)
IF	BGL Stable ** [ie ± 1.0 mmol/L]	**No Change**
IF	↑ BGL Rising**	↑ Increase rate by 2 units/hour (2 mL/hr)
11.0 – 14.0 **IF**	↓ BGL Falling**	↑ Increase rate by 1 unit/hour (1 mL/hr)
IF	BGL Stable ** [ie ± 1.0 mmol/L]	↑ Increase Rate by 2 units/hour (2 mL/hr)
IF	↑ BGL Rising**	↑ Increase Rate by 3 units/hour (3 mL/hr)
>14.0		**Check that infusion is correctly setup** **NOTIFY MEDICAL OFFICER**

** Compared to the previous reading: ie review the current BGL with regard to the previous reading – is it falling, stable or rising?

If BGL is >6.5 mmol/L, STABLE means within + 1.0 mmol/L of the last reading (eg if BGL 7.4 mmol/L: stable if next BGL is in the 6.4-8.4 mmol/L range)

The rate of infusion of insulin is determined by hourly bedside capillary blood glucose level measurement. The infusion rate must be ceased in the event of hypoglycaemia but hourly BGL monitoring must continue even if the insulin infusion is temporarily switched off.

Alternate option 2- based on CPOC UK[29]

Figure 4 - Insulin rate adjustments and titration

Glucose (mmol/l)	Insulin rates (ml/h) Start on standard scale unless otherwise indicated				
	Reduced Rate Scale For use in insulin sensitive people with diabetes (frail older, renal patients or those who usually need less than 24 units per day	Standard Scale (First choice in most cases)	**Increased Rate Scale** For use Insulin resistant people with diabetes– (Patients using > 100 units per day preadmission or with BMI > 35 kg/m^2)	Customised Scale	Customised Scale
NB If patient is on basal insulin, continue basal insulin.					
< 6.0	0*	0*	0*		
6.1 to 8.0	0.5	1	2		
8.1 to 11.0	1	2	4		
11.1 to 15.0	2	4	6		
15.1 to20.0	3	5	7		
20.1 to 28.0	4	6	8		
28.1 or more	6	8	10		

*Treat Hypoglycaemia **and restart IV insulin within 20 minutes**. The half-life of intravenous insulin is very short (seven to eight minutes) and restarting the VRIII promptly minimises the risk of ketoacidosis.

POST-OPERATIVE MANAGEMENT

7.5 Nausea and Vomiting

Post-operative nausea and vomiting need to be carefully treated for all individuals with diabetes, and ongoing BGL monitoring performed.

7.6 Glycaemic Monitoring

Continue hourly BGL monitoring until the person leaves the recovery area.

If the BGL has been stable (and within target range) while in the recovery area, BGL monitoring can be decreased to 2 hourly if type 1 diabetes, or 2-4 hourly if type 2 diabetes.

If BGLs have been unstable or if VRII, hourly monitoring is required.

7.7 Variable Rate Insulin Infusion in the post-operative period

7.7.1 Initiation VRII

A decision to initiate intravenous insulin infusion can be made if:

- BGL >10 mmol/L twice post-operatively for cardiothoracic surgery or
- BGL >10 mmol/L twice for patients in intensive care units.

Refer to the intra-operative section *7.4 Variable Rate Insulin Infusion* on page 32 for an algorithm for initiating VRII.

7.7.2 Cessation of VRII

VRII can be ceased if ALL of the below are met;

- There is no evidence of diabetic ketoacidosis.
- The person is able to eat (tolerating at least 50% of normal oral intake/has commenced enteral feeds), or the patient is commenced on Total Parenteral Nutrition (TPN).
- At least two hours before discontinuing the VRII, an alternative management plan for glycaemic control has been implemented.

Ideally, VRII should be ceased after breakfast, with a dose of subcutaneous insulin (or oral AHG) given before breakfast.

If the person is not able to tolerate oral intake a VRII should continue with daily electrolyte monitoring.

Recommencing subcutaneous insulin in place of a VRII:

Once the person is eating 50% or more of their usual enteral intake, the TDD (total insulin infused in a 24 hour period) should be calculated and given as below

- 50% subcutaneously as basal insulin (e.g. Optisulin or if type 1 diabetes Levemir is an option)
- Usual rapid acting insulin boluses with meals can be restarted. Additional correctional insulin boluses may be required, as per local guidelines.
- If the person is not usually on insulin boluses with meals, the meal-time bolus doses should be calculated as follows; 50% of the TDD divided by 3 (assuming 3 meals/day).

Please see section 7.4.3 Insulin Pumps on page 33 for information on insulin pumps.

7.7.3 Restarting the Insulin Pump

If an insulin pump has been disconnected intra-operatively due to initiation of a VRII, the insulin pump can be restarted at the patient's usual pre-hospital rates and the VRII ceased after a two-hour overlap.

Please note the following contraindication to insulin pump recommencement:

- Inability to resume eating 50% or more of usual intake.
- Vomiting
- Ketones >1.0 mmol/L
- Acute change in conscious state/mental status
- Inability to demonstrate competence with pump management
  - Procedures involving anaesthesia that alter the patient's capability to manage the pump
- Recurrent, persistent or unexplained episodes of hypoglycaemia or hyperglycaemia or unresolved pump failure
- Risk of suicide

If any of the above is present, insulin pump therapy should not be recommenced until further review by a diabetes specialist team.

7.8 Basal Bolus Insulin Regimen

Basal bolus insulin regimen includes basal insulin cover (e.g. insulin glargine) and a rapid acting insulin (e.g. insulin aspart) to mimic physiological responses to food intake or when hyperglycaemia occurs (e.g. >12 mmol/l). This is an alternative to 'sliding scale insulin' where short/rapid acting insulin boluses (e.g. Actrapid) are administered solely based on the BGL at the time unrelated to meals or previous insulin doses. The use of 'sliding scale insulin' as a sole therapy is not recommended.

'Supplemental insulin' via a protocol given in addition to the patient's usual diabetes medication is more appropriate for correction of elevated glucose levels.

A 'basal-bolus-supplemental' insulin approach has been shown to be superior to sliding scale insulin in improving glycaemic control and ease of implementation[32,33,34,35] with no concurrent increase in hypoglycaemia. It is a 'proactive' approach, adding supplemental rapid-acting insulin boluses to correct for hyperglycaemia, in addition to scheduled mealtime boluses. It also benefits from having defined times for nurses to check the BGL (pre-meals and pre-bed). Pre-emptive insulin boluses and more structured timing for checking BGLs result in insulin doses being adjusted in a more predictable manner.

An example basal bolus insulin regimen (without a correctional supplemental component) is provided below. Local basal bolus protocols should be used where available.

32 Zaman Huri H, Permalu V, Vethakkan SR. Sliding-scale versus basal-bolus insulin in the management of severe or acute hyperglycemia in type 2 diabetes patients: a retrospective study. *PLoS One*. 2014;9(9):e106505. doi:10.1371/journal.pone.0106505

33 Roberts GW, Aguilar-Loza N, Esterman A, Burt MG, Stranks SN. Basal–bolus insulin versus sliding-scale insulin for inpatient glycaemic control: a clinical practice comparison. *Med J Aust*. 2012;196(4):266-269. doi:10.5694/mja11.10853

34 Umpierrez GE, Palacio A, Smiley D. Sliding scale insulin use: myth or insanity? *Am J Med*. 2007;120(7):563-567. doi:10.1016/j.amjmed.2006.05.070

35 Umpierrez GE, Smiley D, Zisman A, et al. Randomized study of basal-bolus insulin therapy in the inpatient management of patients with type 2 diabetes (RABBIT 2 trial). *Diabetes Care*. 2007;30(9):2181-2186. doi:10.2337/dc07-0295

Figure 5 - A Sample basal bolus insulin chart generated using the NSW Agency for Innovation Thinksulin app. https://aci.health.nsw.gov.au/networks/endocrine/inpatient-management-of-diabetes-mellitus

Affix patient label here

BASAL BOLUS INSULIN GUIDE

HOW TO START BASAL BOLUS THERAPY?

Basal bolus therapy is considered the ideal and physiological way of administering insulin and is preferred for inpatients who have blood glucose levels outside the target range.

Step 1: Calculate Total Daily Dose (TDD) of Insulin

Current Diabetes Treatment	TDD for pts age ≤70 yrs AND eGFR ≥30mLs/min	TDD for pts age >70years OR eGFR <30mL/min
	0.5 units/kg	0.25 units/kg
When starting basal bolus therapy withhold current diabetes treatment (insulins, GLP1 and oral medications)		

Step 2: Insulin Requirements

Basal - 50% of TDD as once daily insulin glargine
Bolus (Prandial) - 50% TDD divided into 3 equal doses of insulin aspart

Example: 60yr old man with weight 80kg and eGFR 65: TDD will be 40 units. Glargine 20 units pre-bed, Aspart (NovoRapid) 7 units before each main meal.

NB: Do not prescribe a STARTING BASAL insulin dose of greater than 40 units.

Step 3: Mandatory BGL review is required every 24 hours

WHAT DO THE DIFFERENT TESTING TIMES TELL US AND HOW TO ADJUST INSULIN DOSE?

Time of BGL	High BGLs (>10mmol/L)	Low BGLs (<4mmol/L)
Before breakfast	Increase basal insulin (glargine)	Decrease basal insulin (glargine)
Before lunch	Increase breakfast rapid insulin	Decrease breakfast rapid insulin
Before dinner (tea)	Increase lunch rapid insulin	Decrease lunch rapid insulin
Before bed	Increase dinner rapid insulin	Decrease dinner rapid insulin

GUIDELINES ON HOW MUCH INSULIN TO ADJUST?

BGLs mmol/L	Insulin dose adjustment (approximate)
5-10	No adjustment
4-5 with no hypo symptoms	Reduce by 10%
4-5 with hypo symptoms or less than 4.0	Reduce by 20%
10-15	Increase by 10%
15-20	Increase by 20%
>20	Seek senior advice: Consider intravenous insulin infusion

7.9 Oral Agents

Patients should recommence their usual management (AHG and/or insulins) once they recommence eating and drinking at least 50% of usual dietary intake, with the following considerations:

1. Metformin
    a. Patients with known impaired renal function (CKD stage 3B or below ie eGFR <45 mL/min/1.73 m2) and who have had major surgery should have their creatinine measured post-operatively and metformin, if required, should only be restarted after renal function has been confirmed to be adequate and no other contraindications.
    b. If there has been minor surgery and the patient can eat and drink immediately after their procedure metformin can be restarted without measuring their renal function.
2. SGLT2 inhibitors
    a. Should only restart when the person has returned to their full normal diet or following discharge from hospital.
    b. Refer to your local hospital, area or state guidelines regarding in-hospital prescribing of SGLT2i.
    c. Patients should be advised to present to a hospital emergency department for clinical assessment and ketone checking if they become unwell or if they are vomiting during the week following the surgery. People with type 2 diabetes will rarely have the meters or ketone testing strips to be able to test themselves at home.

8. DISCHARGE PLANNING

All people with diabetes need to be provided with information on discharge with regard to their usual diabetes care.

The surgical team and anaesthetists should ensure that all relevant in-hospital tests and issues with regard to glycaemic control are conveyed to the patient's GP and diabetes physician including:

- Any HbA1c performed.
- New onset hyperglycaemia during hospital admission.
- Any glycaemic related complications such as DKA/HHS.
- Changes made to diabetic medications during hospital stay.
- Planned reintroduction of therapies temporarily ceased perioperatively.
- Changes to medications that may impair glycaemic control such as corticosteroids.
- Concerns regarding administration of diabetes medications or self-management of diabetes.

The person with diabetes should be provided with written discharge documentation which should include sick day management plans and details of who to contact for advice regarding post-discharge management of diabetes.

9 Appendix A – Sample Primary Referral Letter

This is a sample information sheet indicating the information required in a primary referral letter. This should be adapted for local use.

Diabetes Info-sheet for Surgical Referral

Patient details

First Name		Last Name	
Sex	Date of Birth		Unit Record Number
Referral for			
Diabetes Status	☐ No diabetes ☐ Pre-diabetes ☐ Type I ☐ Type 2 ☐ Other-specify:		
Duration of diabetes		Referring doctor	
Current medications		Type of doctor	GP/Endocrinologist/General Physician/Other - specify
		Contact number	
		Complications of diabetes	
		☐ Peripheral Neuropathy ☐ Autonomic Neuropathy ☐ Nephropathy, ☐ Stage 3 ☐ Stage 4 ☐ Stage 5 ☐ Retinopathy, ☐ Proliferative, ☐ Non-proliferative ☐ Diabetic foot disease, ☐ Amputations ☐ Ischaemic heart disease ☐ Stroke	
		Co-morbidities	

Clinical and laboratory results	(Please attach results of recent biochemistry, liver function tests, full blood count)

Latest BP:_____ BMI:_____

HbA1c: _____ Date of test_____

eGFR: _____ Date of test:_____

Other information of clinical significance (e.g., hypoglycaemic unawareness, recent hospitalisations, diabetic ketoacidosis, severe hypoglycaemia).

Details of cardiovascular tests, assessments and other tests should be included/attached.
Please include date of last events, if any.

1.

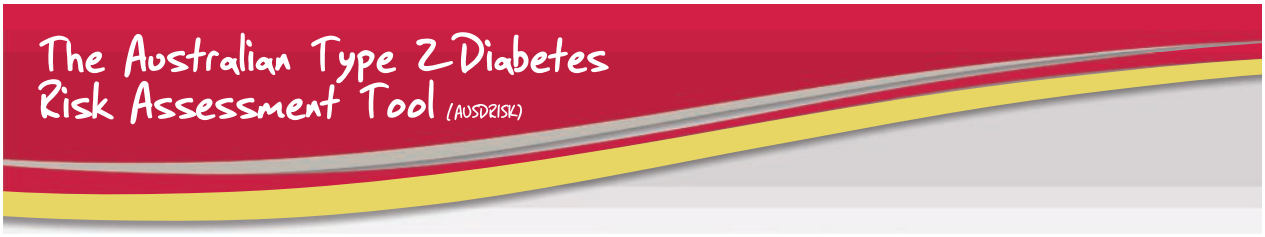
2.

3.

10 Appendix B – AUSDRISK calculator

http://www.health.gov.au/internet/main/publishing.nsf/Content/diabetesRiskAssessmentTool

The Australian Type 2 Diabetes Risk Assessment Tool was developed by the Baker IDI Heart and Diabetes Institute on behalf of the Australian, state and territory governments as part of the COAG initiative to reduce the risk of type 2 diabetes. The questionnaire predicts the 5-year risk of developing type 2 diabetes.



1. Your age group

Under 35 years	☐	0 points
35 – 44 years	☐	2 points
45 – 54 years	☐	4 points
55 – 64 years	☐	6 points
65 years or over	☐	8 points

2. Your gender

Female	☐	0 points
Male	☐	3 points

3. Your ethnicity/country of birth:

3a. Are you of Aboriginal, Torres Strait Islander, Pacific Islander or Maori descent?

No	☐	0 points
Yes	☐	2 points

3b. Where were you born?

Australia	☐	0 points
Asia (including the Indian sub-continent), Middle East, North Africa, Southern Europe	☐	2 points
Other	☐	0 points

4. Have either of your parents, or any of your brothers or sisters been diagnosed with diabetes (type 1 or type 2)?

No	☐	0 points
Yes	☐	3 points

5. Have you ever been found to have high blood glucose (sugar) (for example, in a health examination, during an illness, during pregnancy)?

No	☐	0 points
Yes	☐	6 points

6. Are you currently taking medication for high blood pressure?

No	☐	0 points
Yes	☐	2 points

7. Do you currently smoke cigarettes or any other tobacco products on a daily basis?

No	☐	0 points
Yes	☐	2 points

8. How often do you eat vegetables or fruit?

Every day	☐	0 points
Not every day	☐	1 point

9. On average, would you say you do at least 2.5 hours of physical activity per week (for example, 30 minutes a day on 5 or more days a week)?

Yes	☐	0 points
No	☐	2 points

10. Your waist measurement taken below the ribs (usually at the level of the navel, and while standing)

Waist measurement (cm) ☐

For those of Asian or Aboriginal or Torres Strait Islander descent:

Men	Women		
Less than 90 cm	Less than 80 cm	☐	0 points
90 – 100 cm	80 – 90 cm	☐	4 points
More than 100 cm	More than 90 cm	☐	7 points

For all others:

Men	Women		
Less than 102 cm	Less than 88 cm	☐	0 points
102 – 110 cm	88 – 100 cm	☐	4 points
More than 110 cm	More than 100 cm	☐	7 points

Add up your points ☐

Your risk of developing type 2 diabetes within 5 years*:

☐ *5 or less: Low risk*
Approximately one person in every 100 will develop diabetes.

☐ *6-11: Intermediate risk*
For scores of 6-8, approximately one person in every 50 will develop diabetes. For scores of 9-11, approximately one person in every 30 will develop diabetes.

☐ *12 or more: High risk*
For scores of 12-15, approximately one person in every 14 will develop diabetes. For scores of 16-19, approximately one person in every 7 will develop diabetes. For scores of 20 and above, approximately one person in every 3 will develop diabetes.

**The overall score may overestimate the risk of diabetes in those aged less than 25 years.*

If you scored 6-11 points in the AUSDRISK you may be at increased risk of type 2 diabetes. Discuss your score and your individual risk with your doctor. Improving your lifestyle may help reduce your risk of developing type 2 diabetes.

If you scored 12 points or more in the AUSDRISK you may have undiagnosed type 2 diabetes or be at high risk of developing the disease. See your doctor about having a fasting blood glucose test. Act now to prevent type 2 diabetes.

11 Appendix C – Efficacy of Oral Anti-hyperglycaemic Agents

The following observations have been made about oral anti-hyperglycaemic agents, based on a systematic review of literature and meta-analysis[36].

1. On commencing a new oral agent, there is an initial effect, but maximal effects are seen after 3-6 months.
2. There is a further 0.2-0.5% decline in HbA1c for every 1% higher baseline HbA1c level (e.g. at HbA1c of 8%, initiating metformin would reduce HbA1c by about 1%, but at HbA1c of 9%, initiation of metformin would reduce HbA1c by about 1.2-1.5%).
3. Different classes of medications have different efficacy in reduction of HbA1c. This is summarised below:

Table 9 - Estimated A1c reduction with typical oral agents

Medication	Estimated A1c reduction (at HbA1c ~8%)	Dosage for maximum effect
Alpha glucosidase inhibitors	~1%	150 mg/day (acarbose)
Biguanides	~1%	1,500 mg/day (metformin)
DPP-4 inhibitors	~0.75%	100 mg/day (sitagliptin and vildagliptin)
Sulphonylureas	~1.25%	8 mg/day (glimepiride)
Thiazolidinedione	~1% (pioglitazone)	30 mg/day (pioglitazone)

The systematic review cited above did not include two classes of newer non-insulin anti-hyperglycaemic medications available currently in Australia, namely the SGLT2 inhibitors and GLP-1 agonists. *Figure 5- Estimated A1c reduction with newer non-insulin anti- hyperglycaemic agents*

Medication	Estimated HbA1c reduction (baseline HbA1c 7.0-10%)
SGLT2 inhibitors	~0.89% (dapagliflozin, 10 mg)[1]
GLP-1 agonists	~1.33% (liraglutide, 1.8 mg)[2] ~1.33% (semaglutide sc)[3]

For more information on non-insulin anti-hyperglycaemic agents, see *Appendix J – Non-insulin Anti-hyperglycaemia Agents* on page 55.

36 Sherifali D, Nerenberg K, Pullenayegum E, Cheng JE, Gerstein HC. The effect of oral antidiabetic agents on A1c levels: A systematic review and meta-analysis. *Diabetes Care* 2010; 33(8):1859-1864

12. Appendix D – Sample Letter to GP for Patients with Elevated HbA1c

Date:

Place patient sticker here

Dear Dr. _____

RE: Elevated BGL or HbA1c Pre-operatively

Your patient as identified above was reviewed in the Pre-Admission Clinic in preparation for surgery.

Their preoperative blood testing revealed an elevated BGL or HbA1c:

BGL:

HbA1c:

As your patient has no known previous history of diabetes or impaired glucose tolerance, these results indicate that they may either have diabetes or are at risk of developing diabetes.

Further monitoring and/or investigation of their blood glucose/HbA1c is warranted.

Thank you for following up on this.

Patient aware of the problem/s:

If there is anything we can do to help you with this, please contact us.

Thank you.

Dr _____

Peri-operative Service.

Provider No: _____

13. Appendix E – Management for Bowel Preparation

Insulin Management when having a Bowel Preparation		
Usual Insulin Regimen	**Morning**	**Evening**
Basal bolus regimens	Withhold rapid-acting insulin. Continue long-acting as usual.	Withhold rapid-acting insulin. Give **half** of long-acting insulin at the usual time.
Regimen consisting of separate injections of rapid-acting and intermediate acting insulin	Withhold rapid-acting insulin. Calculate morning and lunch doses of all rapid-acting insulin (do not include dinner doses). Give **half** of this as intermediate acting insulin.	Withhold rapid-acting insulin. Give **half** of intermediate acting insulin at usual time in the evening.
Pre-mixed insulin regimens	Give **half** of the usual dose at the usual time.	Give **half** of insulin dose at usual time in the evening.
Co-formulated insulin eg Ryzodeg	Give **half** of the usual dose at the usual time.	Give **half** of insulin dose at usual time in the evening.

Examples:

Basal-bolus regimen with insulin Optisulin (glargine) as basal insulin	
Usual insulin regimen	Humalog™ 8 units before breakfast Humalog™ 6 units before lunch Humalog™ 10 units before dinner Optisulin™ 24 units before bedtime
For day of bowel preparation	Withhold Humalog™ Optisulin™ ½ x 24= 12 units before bedtime

Regimen consisting of separate injections of rapid-acting and intermediate acting insulin	
Usual insulin regimen	Humalog™ 8 units before breakfast Humalog™ 6 units before lunch Humalog™ 10 units before dinner Isophane™ 20 units before bedtime
For day of bowel preparation	Withhold Humalog™ Isophane™ ▪ Morning – give ½ x (8+6) = 7 units ▪ Before bedtime- give ½ x 20 = 10 units

Pre-mixed insulin regimens	
Usual insulin regimen	Novomix30™ 36 units before breakfast Novomix30™ 44 units in evening
For day of bowel preparation	Novomix30™ ▪ Morning – give ½ x 36 = 18 units ▪ Evening – give ½ x 44 = 22 units

Coformulated insulin regimens	
Usual insulin regimen	Ryzodeg 70/30 40 units before dinner
For day of bowel preparation	Ryzodeg70/30 20 units in evening

14. Appendix F – Sample Patient Instructions for Bowel Preparation

Instructions for Patients with Diabetes

Patient details

First Name	Last Name	
Sex	Date of Birth	Unit Record Number
Bowel Preparation for (e.g. colonoscopy, barium enema):		

The Day before your Procedure (Fluids only)

Withhold all non-insulin hypoglycaemic agents (i.e., all diabetes tablets, as well as non-insulin injectable agents such as Byetta, Trulicity, Ozempic).

If you are on insulin treatment, follow the advice below. Please show this document to your doctor and ask them to write out the actual amount of insulin you should have on the day before the procedure.

You need a lower dose of insulin than usual in the evening before the procedure, due to the bowel clean-out.

Usual insulin				
	Breakfast	Lunch	Dinner	Bed
On day of fluids only for bowel preparation, take				
	Morning	Middle of the day	Evening	Bed

BGL monitoring

Monitor your blood glucose levels (BGLs) every 2 hours during the day from rising till bedtime.

Aim: BGLs 5-10 mmol/L (4 -12 mmol/L acceptable).

If **BGL is less than 5 mmol/L** at any stage: have extra sugar-containing cordial or jelly (**not red, blue** or **orange** in colour) or clear apple juice; check BGL 15-30 minutes later. Repeat cordial/jelly if necessary.

If **BGLs are tending to run on higher side**: avoid sugary liquids and have more clear broths or diet cordial.

If **BGL is greater than 12 mmol/L** and you take rapid acting insulin, then you should give yourself a correction dose. e.g. Novorapid or Humalog 2-4 units. You should then **not have another correction dose for 4 hours** as you need to allow time for each dose of insulin to have full effect. If you are not sure what to do please contact your GP or Endocrinologist.

15. Appendix G – Sample Pre-surgery Instructions for Patients with Diabetes

Instructions for Patients with Diabetes

Patient details

First Name	Last Name	
Sex	Date of Birth	Unit Record Number
Surgical Procedure		

You are going to have a procedure. We want to make sure that your diabetes is managed adequately before you come to hospital. If you have diabetes in pregnancy or if you are having a bowel preparation for colonoscopy, or barium enema, please ask your doctor to provide you a different set of instructions specifically for those situations.

Medication adjustments

On the day before your admission

Take all your diabetes tablets, non-insulin injectable agents (e.g. Ozempic™) and insulin as you would normally do.

Exception: **STOP** any SGLT2i agents **2 days before** procedure or surgery unless you are having a minor procedure. SGLT2i agents include: Forxiga, Glyxambi, Jardiance, Jardiamet, Qtern, Segluromet, Steglatro, Steglujan, Xigduo.

On the day of your procedure	
Diabetes tablets	Do not take them in the morning or at lunchtime.
Non-insulin injectable agents (e.g. Byetta™, Trulicity™, Ozempic™)	Do not take them.
Basal Insulin (e.g. Optisulin™, Toujeo™, Semglee™, Levemir™),	Take as usual.
Intermediate Acting Insulin (e.g. Protaphane, Humulin NPH)	Take _____ units in the morning. Omit lunchtime dose.
Rapid/short-acting Insulin *(Doctor to write type/brand above, and advise to omit if morning procedure or take it with light breakfast on the right if afternoon procedure)*	Do not take. Take _____ units in the morning. Omit lunchtime dose.
Pre-mixed Insulin	Take _____ units in the morning. Omit lunchtime dose.
Co-formulated insulin	Take _____ units in the morning.
Insulin Pump Therapy	Keep the basal subcutaneous insulin infusion rate(s) at the usual level. If recent BGLs have been trending low, change to 80% temp basal OR set exercise blood glucose target if auto mode pump).

Instructions for Patients with Diabetes

Patient details

First Name	Last Name	
Sex	Date of Birth	Unit Record Number
Surgical Procedure		

You are going to have a procedure and we would like to make sure that your diabetes is managed adequately before you come to hospital. If you have diabetes in pregnancy or if you are having a bowel preparation for colonoscopy, or barium enema, please ask your doctor to provide you a different set of instructions.

Medication adjustments

Current diabetes medications:

Oral medications:

- ☐ Metformin
- ☐ Gliclazide/Glibenclamide/Glipizide/Glimepiride
- ☐ Pioglitazone
- ☐ Acarbose
- ☐ Alogliptin/Sitagliptin/Saxagliptin/Linagliptin/Vildagliptin
- ☐ Empagliflozin/Dapagliflozin/Ertugliflozin

Non-insulin injectable medications:

- ☐ Exenatide(Byetta) / Dulaglutide (Trulicity) / Semaglutide (Ozempic)

Insulin:

- ☐ Basal insulin (Insulin glargine- Optisulin/Semglee/Toujeo, Insulin detemir- Levemir)
- ☐ Intermediate Acting Insulin (Isophane insulin- Protaphane, Humulin NPH)
- ☐ Short acting insulin (Neutral insulin- Actrapid/Humulin R)
- ☐ Ultra-rapid or rapid-acting Insulin (Insulin aspart- Fiasp/Novorapid, Insulin lispro-Humalog, Insulin glulisine-Apidra)
- ☐ Pre-mixed insulin- (Humulin 30/70, Mixtard 30/70, Mixtard 50/50, Novomix 30, Humalog Mix25, Humalog Mix50)
- ☐ Co-formulated insulin (Ryzodeg 70/30)

On the day before your admission for the procedure:
Take all your usual medications as you would normally do.

Exception: **STOP** any SGLT2i agents **2 days before** procedure or surgery. SGLT2i agents include: Forxiga, Glyxambi, Jardiance, Jardiamet, Qtern, Segluromet, Steglatro, Steglujan, Xigduo.

On the day of your procedure	
Basal Insulin _____	Take as usual.
Intermediate Acting Insulin: _____	Take _____ units in the morning. Omit lunchtime dose.
Ultra-rapid or rapid-acting Insulin:_____ *(Doctor to write type/brand above, and advise on the right to omit if morning procedure or take it with light breakfast if afternoon procedure)*	☐ Do **not** take. ☐ Take _____ units in the morning. ☐ Omit lunchtime dose.
Pre-mixed Insulin: _____	Take _____ units in the morning. Omit lunchtime dose.
Co-formulated insulin: _____	
Insulin Pump Therapy	Keep the basal subcutaneous insulin infusion rate at the usual level. If recent BGLs have been trending low, change to 80% temp basal OR set exercise blood glucose target if auto mode pump).

Blood Glucose Measurement

If you are only treated with diabetes tablets measure your blood glucose level when you wake up and then every 2 hours until you get to hospital. Write these levels down and give them to the nurse who admits you.

If you are on insulin treatment, then measure your blood glucose level when you wake up and then every hour until you get to hospital. Write these levels down and give them to the nurse who admits you.

What do I do if my blood glucose goes low (less than 5 mmol/L) or high (more than 12 mmol/L)?

Hypoglycaemia (BGL less than 5 mmol/L on day of surgery)
▪ Drink 125 mL (1/2 cup) of clear apple juice OR have 1 dessertspoon (15 mL) of honey. ▪ Check your BGL every 15 minutes. Repeat the juice/honey if your blood glucose is still less than 5 mmol/L. ▪ If you are using an Insulin Pump: Also lower the basal infusion rate by 20% (temporary basal) or if automode pump set the exercise glucose target of 8.3 mmol/L.
Hyperglycaemia (BGL more than 12 mmol/L on day of surgery)
If you have rapid or short acting insulin ie FiAsp/NovoRapid / Humalog / Apidra / Actrapid / Humulin R Insulin. *(circle what is applicable)* When Blood glucose level is 12-14 mmol/L: Take: _____ Units When Blood glucose level is over 14 mmol/L: Take: _____ Units If you do not have access to rapid or short acting insulin, please ring the Peri-operative Unit for advice. The phone number is: _____

In either of the above cases, make sure you inform the nurse at admission that your blood glucose was less than 5 mmol/L or was more than 12 mmol/L on the day of the procedure.

Blood glucose diary

Time (every 2 hours)	Blood Glucose (mmol/L)	Comments (e.g. actions for low or high readings)

16. Appendix H: What is HbA1c and what is its role in management of dysglycaemia?

16.1 What is HbA1c? [37]

HbA1c is a form of glycosylated haemoglobin that provides a useful longer-term measure of blood glucose control over a period of 2-3 months. The rate of glycosylation is dependent on the blood glucose level (BGL). Glycosylated haemoglobin accumulates in the red blood cell during its circulation in the body (approximately 120 days). Higher HbA1c levels are linked to higher risk of microvascular complications (retinopathy, nephropathy and neuropathy). HbA1c should be cautiously interpreted in conditions that affect red blood cell survival, such as acute haemorrhage, iron deficiency anaemia, haemoglobinopathies, and late-stage chronic kidney disease.

16.2 Use of HbA1c in clinical practice

HbA1c is used for diagnosing diabetes and for monitoring control of glycaemia[38]. HbA1c of ≥6.5% with symptoms of hyperglycaemia is considered to be diagnostic of diabetes. A confirmatory test is needed to confirm the diagnosis in asymptomatic patients with positive test results. HbA1c levels between 5.7% -6.4% indicate increased risk of diabetes.

When monitoring glycaemic control in people with different forms of diabetes, a target HbA1c is generally set at recommended or individualised levels depending on patient co-morbidities or circumstances. Adjustment of diabetes therapy is made to achieve and maintain HbA1c at or below this level[39,40].

37 HbA1c and monitoring glycaemia Patrick J Phillips Volume 41, No.1, January/February 2012

38 d'Emden MC, Shaw JE, Colman PG, *et al.* The role of HbA1c in the diagnosis of diabetes mellitus in Australia. *Med J Aust* 2012; 197 (4): 220-221

39 d'Emden MC, Shaw JE, Jones GR and Cheung NW. Guidance concerning the use of glycated haemoglobin (HbA1c) for the diagnosis of diabetes mellitus. *Med J Aust* 2015; 203 (2): 89-90

40 Bell K, Shaw JE, Maple-Brown L *et al*. A position statement on screening and management of prediabetes in adults in

17. Appendix I – Types of Insulin

The following is adapted from the National Institute of Diabetes and Digestive and Kidney Diseases[41].

Type of Insulin	Brand Name	Generic Name	Onset	Peak	Duration
Ultra-rapid acting	FiAsp	Insulin aspart	5-10 min	30 min	3.5-4 hrs
Rapid-acting	NovoRapid Apidra Humalog Humalog U200	Insulin aspart Insulin glulisine Insulin lispro	15 min	30 to 90 min	3 to 5 hrs
Short-acting	Humulin R Actrapid	Insulin neutral-human	30 to 60 min	2 to 4 hrs	5 to 8 hrs
Intermediate-acting	Protaphane Humulin NPH	Insulin Isophane - human	1 to 3 hrs	8 hrs	12 to 16 hrs
Basal	Levemir	Insulin detemir	3-4 hours	3-8 hours	16 to 24 hrs
	Optisulin Toujeo Semglee	Insulin glargine	1 hour	No clear peak	20 to 26 hrs
Pre-mixed insulin-combination of short-acting insulin and Intermediate-acting insulin	Humulin 30/70 Mixtard 30/70	30% Insulin neutral-human and 70% Insulin Isophane-human	30 to 60 min	Varies	10 to 16 hrs
	Mixtard 50/50	50% Insulin neutral-human and 50% Insulin Isophane-human	30 to 60 min	Varies	10 to 16 hrs
Pre-mixed insulin-combination of rapid-acting insulin and intermediate-acting insulin	Humalog Mix 25	25% insulin lispro and 75% insulin lispro protamine	15 min	Varies	10 to 16 hrs
	Humalog Mix 50	50% insulin lispro and 50% insulin lispro protamine	15 min	Varies	10 to 16 hrs
	NovoMix 30	30% insulin aspart and 70% insulin aspart protamine	15 min	Varies	10 to 16 hrs
Co-formulated insulin-combination of rapid-acting insulin and long-acting insulin	Ryzodeg 70/30	Insulin degludec 70% and insulin aspart 30%	5–20 min	1 hour	36-48 hours

primary care in Australia. *Diabetes Res Clin Practice* 164 (2020) 108188

41 Diabetes and Digestive and Kidney NI of. Insert C: Types of Insulin. http://diabetes.niddk.nih.gov/dm/pubs/medicines_ez/insert_C.aspx.

18. Appendix J – Non-insulin Anti-hyperglycaemic Agents

Class	Examples	Cellular action	Physiological action	Advantages	Disadvantages
Biguanides	Metformin	Activates AMP-kinase	Decrease hepatic glucose production	Extensive experience No hypoglycaemia ↓ CVD (UKPDS)	GI side effects Lactic acidosis (rare/unproven) Vitamin B12 deficiency Contraindicated in CKD, acidosis, hypoxia, dehydration, etc
Sulphonylurea	Gliclazide Glibenclamide Glipizide Glimepiride	Closes K_{ATP} channels on β-cell plasma membranes	↑ insulin secretion	Extensive experience ↓ microvascular risk (UKPDS)	Hypoglycaemia ↑ weight Low durability (loses effect after 2-3 years)
Thiazolidine-diones	Pioglitazone Rosiglitazone	Activates the nuclear transcription factor PPAR-γ	↑ insulin sensitivity	No hypoglycaemia Durability ↑ HDL-C ↓ Triglycerides (pioglitazone) ? ↓ CVD events (PROactive, pioglitazone)	↑ weight Oedema/heart failure Bone fractures/↓ BMD ↑ LDL-C (rosiglitazone) ? ↑ MI (meta-analyses, rosiglitazone)
α-Glucosidase inhibitors	Acarbose	Inhibits intestinal α-glucosidase	Slows intestinal carbohydrate digestion/absorption	No hypoglycaemia ↓ postprandial glucose excursions ? ↓ CVD events (STOP-NIDDM) Non-systemic	Generally modest HbA1c efficacy GI side effects (flatulence, diarrhoea) Frequent dosing schedule
DPP-4 inhibitors	Sitagliptin Vildagliptin Saxagliptin Linagliptin Alogliptin	Inhibits DPP-4 activity, increasing postprandial active incretin	↑ insulin secretion (glucose-dependent) ↓ glucagon secretion (glucose dependent)	No hypoglycaemia Well tolerated	Angioedema/urticaria ? acute pancreatitis ? ↑ heart failure hospitalisations
SGLT2 inhibitors	Dapagliflozin Empagliflozin Ertugliflozin	Inhibits SGLT2 in the proximal nephron	Blocks glucose re-absorption by the kidney, increasing glycosuria	▪ Mortality benefit ▪ No hypoglycaemia ▪ ↓ weight ▪ ↓ BP ▪ ? renoprotective ▪ Effective at all stages of T2DM	Genitourinary infections ▪ Polyuria Volume depletion, hypotension, dizziness ▪ ↑ LDL-C ▪ ↑ creatinine (transient)

GLP-1 receptor agonists	Exenatide Liraglutide Dulaglutide Semaglutide	Activates GLP-1 receptors	▪ ↑ insulin secretion (glucose dependent) ▪ ↓ glucagon secretion ▪ Slows gastric emptying ▪ ↑ satiety Cardiovascular benefit (liraglutide, LEADER)	▪ No hypoglycaemia ▪ ↓ weight ▪ ↓ Postprandial glucose excursions	▪ GI side effects ▪ ↑ heart rate ▪ ? acute pancreatitis ▪ C-cell hyperplasia/ medullary thyroid tumour in animals ▪ Injections

Adapted and modified from: Inzucchi SE, Bergenstal RM, Buse JB, et al. Management of hyperglycemia in type 2 diabetes, 2015: a patient-centered approach: update to a position statement of the American Diabetes Association and the European Association for the Study of Diabetes. *Diabetes Care*. 2015;38(1):140-149.

19. Appendix K – Guide to Pre-operative Insulin Management

Insulin regimen	Morning procedure	Afternoon procedure
Evening basal insulin only	No dose change.	No dose change.
Morning basal insulin only	No dose change.	No dose change.
Basal bolus regimen	Omit the morning and lunch time rapid/short-acting insulin. Keep the basal dose unchanged.	Advise half the morning rapid/short-acting insulin with light breakfast. Omit the lunch dose(fasting). Keep the basal and evening meal dose unchanged if eating.
Pre-mixed insulin	Halve the usual morning dose. Omit lunchtime dose (if any) if not eating. Leave the evening meal dose unchanged.	Advise half the usual morning dose with light breakfast. Omit lunchtime dose (if any). Leave the evening meal dose unchanged if eating.
Co-formulated insulin eg Ryzodeg	Omit on morning of surgery for morning procedure. Give usual morning dose at lunchtime if able to eat by then. If usually lunchtime dose give as usual if able to eat by then. If patient is on morning or lunchtime only dose, give usual dose with evening meal if not able to eat before then.	Advise half of usual morning dose with light breakfast. Omit if usually lunchtime dose. If usually lunchtime dose only give usual dose with evening meal if able to eat by then. If usually evening dose, give usual dose with evening meal if eating. If unable to eat post op by evening recommend insulin infusion or switch to basal bolus insulin.
Intermediate acting insulin with 2-3 rapid-acting or short-acting insulin doses for meals	Calculate the total dose of all insulins for the morning and lunch. Half of the total insulin dose should be given as an intermediate acting insulin only in the morning. Leave evening meal and pre-bed doses unchanged.	Calculate the total dose of all insulins for the morning and lunch. Half of the total insulin should be given as an intermediate acting insulin only in the morning. Half the morning rapid-acting insulin can be given with a light-breakfast. Leave evening meal (if eating) and pre-bed doses unchanged.
Subcutaneous insulin pump	Continue basal infusion at usual rates - or: Use temporary basal of 80% if fasting BG <5 mmol/L or HbA1c <48 mmol/mol (6.5%). If automode pump, set exercise blood glucose target.	Half calculated bolus at breakfast; Continue basal infusion at usual rates- or use temporary basal of 80% if fasting BG <5 mmol/L. If automode pump, set exercise blood glucose target.

20. Appendix L: ADS-ANZCA-ADEA-NZSSD Periprocedural DKA with SGLT2i Use in People with Diabetes Alert

ALERT UPDATE July 2022

Periprocedural Diabetic Ketoacidosis (DKA) with SGLT2 Inhibitor Use In People with Diabetes

Background

Sodium-glucose co-transporter-2 inhibitors (SGLT2i) are oral medications that promote glucose excretion in the urine for the treatment of type 2 diabetes. Note that SGLT2i are not approved for use in the management of type 1 diabetes in Australia or New Zealand, although they are sometimes used off-label in this setting.

- Over the last few years there has been an increasing number of reports of people with type 2 diabetes who are taking these medications developing severe acidosis requiring ICU/HDU admission during the peri-operative period.
- SGLT2i carry a small but definite risk of severe diabetic ketoacidosis (DKA), which may be associated with near-normal or only mildly elevated blood glucose levels (i.e. 'euglycaemic' ketoacidosis [euDKA]); therefore, a normal or only modestly elevated plasma glucose level does not exclude the diagnosis.
- The risk is increased if the person with diabetes has been fasting or has very restricted dietary (especially carbohydrate) intake, has undergone bowel preparation and/or a surgical procedure, is dehydrated or has an intercurrent illness such as active infection.
- Blood ketone testing is strongly recommended to detect and monitor DKA as urine ketone testing may be unreliable.
- It should be noted that ketone levels may be elevated in a person with diabetes undergoing colonoscopy due to the decreased carbohydrate intake during the preparation for colonoscopy, even in people who are not administered SGLT2i. In people with and without type 2 diabetes and not taking SGLT2i, ketone levels up to 1.7 mmol/L have been reported in the absence of acidosis.
- At present, as there have been no reports of DKA in a person taking SGLT2i that does not have diabetes; SGLT2i should not be discontinued in this situation.

Clinicians should consider DKA/euDKA in a person with diabetes taking SGLT2i who has one or more of:

- Symptoms of abdominal pain, nausea, vomiting, fatigue or metabolic acidosis
- Finger prick capillary blood ketone (or blood beta-hydroxybutyrate) levels >1.0 mmol/L with or without hyperglycaemia
- Low (negative) base excess (BE) < -5 mmol/L indicating metabolic acidosis on arterial or venous blood gasses.

SGLT2i agents currently available in Australia include dapagliflozin (Forxiga), empagliflozin (Jardiance), and ertugliflozin (Steglatro), as well as fixed dose combinations with metformin (Xigduo, Jardiamet, Segluromet) or with gliptins (Glyxambi, Qtern, Steglujan).

SGLT2i agents currently registered in New Zealand include dapagliflozin (Forxiga), empagliflozin (Jardiance) and canagliflozin (Invokana). N.B. only dapagliflozin (Forxiga) and empagliflozin (Jardiance) are currently commercially available.

Advice for peri-procedural practice

- When commencing a person with diabetes on SGLT2i, clinicians should inform them about the risk of DKA associated with procedures, ideally with written information and management plans. It is advisable to document that the advice has been provided.
- For surgery and procedures requiring one or more days in hospital, omit SGLT2i for at least 3 days (i.e. 2 days pre-procedure, and the day of procedure). This may require increasing other glucose-lowering drugs during that time. If the SGLT2i is part of a fixed dose combination, this will lead to withdrawal of two glucose-lowering drugs unless the second drug is prescribed separately.
- For surgery and procedures including colonoscopy requiring bowel preparation with carbohydrate restriction commencing on the day prior to the procedure, omit SGLT2i for at least 3 days (i.e. 2 days pre-procedure, and the day of procedure).
- For day-stay procedures (including gastroscopy) that do not require bowel preparation, SGLT2i can be stopped just for the day of procedure. However, fasting before and after the procedure should be minimised.

On admission

- If the person with diabetes is unwell: strongly consider postponing non-urgent procedures.
- Measure both blood glucose and blood ketone levels. If the person with diabetes has ceased the SGLT2i 3 days pre-procedure, is clinically well and ketones are < 1.7 mmol/L, proceed. Consider hourly blood glucose and blood ketone testing during the procedure and 2 hourly following the procedure until the person with diabetes is eating and drinking normally.
- If the SGLT2i has not been omitted for 3 days (i.e. 2 days prior to surgery and the day of surgery) or if the SGLT2i has been taken on the day of surgery or the day procedure, the course of action depends on the urgency of the procedure, comorbidities of the person with diabetes, surgical factors, HbA1c, blood ketones, and base-excess (see table). *Note HbA1c >9% or 75 mmol/mol is an indicator of insulin insufficiency. It confers a higher risk of DKA in this setting.*
- A person with diabetes on SGLT2i undergoing emergency surgery should be admitted post-procedure to a ward capable of managing diabetic ketoacidosis in collaboration with endocrinology and critical care.

- **At any point before, during or after a procedure, if the blood ketone level is >1.0 mmol/L in an unwell person with diabetes** who has been on an SGLT2i, take arterial or venous blood gases to measure the (standard) Base Excess (SBE). If ketones are > 1.0 mmol/L and base excess <-5 mmol/L, the person with diabetes has presumed DKA, and if the blood glucose < 14 mmol/L, presumed euDKA.
  - For the person with diabetes in a ward, or where there is no critical care expert, the rapid response (MET) team should be activated or an ICU contacted, and collaboration sought with endocrinology or general medicine.
  - In other critical care areas, anaesthetists or emergency medicine physicians should liaise with endocrinology and ICU. Management priorities include: rehydration; intravenous insulin (with added glucose infusion if the BGL is <15mmol/l); hourly monitoring of blood glucose, ketones and blood gases with appropriate action to escalate or de-escalate treatment.
- A person with diabetes with DKA and euDKA should be reviewed by an endocrinologist or physician on-call and critical care specialists. If required, contact a tertiary hospital for expert advice.

Post procedure

- Restart SGLT2i post-operatively when the person with diabetes is eating and drinking normally or close to discharge from hospital.
- A person with diabetes who has day surgery/procedures should only recommence SGLT2i when they resume full oral intake. Consider delaying recommencement of SGLT2i for a further 24 hours but also consider potential for hyperglycaemia.
- Provide the person with diabetes with written advice to seek medical advice if unwell in the week following the procedure.

Table: Suggested Management of CLINICALLY WELL a person with diabetes who has NOT ceased SGLT2i

Ketones	Base Excess	Comments
<1	> -5	**No ketosis and no metabolic acidosis.** Consider proceeding with day surgery: hourly monitoring of blood ketones during the procedure, and 2nd hourly following the procedure until eating and drinking normally or discharged. Where blood gas analysis is not available proceed only if added risk is consistent with goals of care. More extensive surgery: consider goals of care and collaboration with endocrinology and critical care. Perioperative insulin and glucose infusion may reduce risk.
>1	> -5	**Ketosis without metabolic acidosis.** Seek endocrinology or general medicine advice. Ketosis without acidosis may reflect starvation, particularly in individuals with HbA1c < 9% (<75 mmol/mol). Consider proceeding, but with perioperative insulin and glucose infusion to reduce risk of ketoacidosis
>1	< -5	**Ketosis with metabolic acidosis.** Postpone non-urgent surgery. Escalate care with endocrinology and critical care. Urgent surgery to proceed with insulin and glucose infusion and ketone monitoring with guidance from endocrinology and/or critical care

Footnote: Blood gas analysis is recommended to assess for presence of metabolic acidosis. Where blood gas analysis is not readily available, and the ketones are > 1.0 mmol/L the procedure should not be performed.

Precaution:

This updated management alert on the use of SGLT2 inhibitors in relation to periprocedural DKA risk should not supplant individualised clinical decisions based on the circumstances of each clinical scenario.

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