

Diabetes Care for an Adult Having Surgery

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Quick Guide

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PERIOPERATIVE MANAGEMENT of SGLT2 INHIBITORS (GLIFLOZINS)

Minor or Daystay surgery¹

Withhold 1 day prior AND day of surgery

Intermediate or Major surgery¹

Withhold 2 days prior AND day of surgery

Encourage preoperative fluid intake whilst obeying fasting restrictions

If SGLT2 inhibitor **NOT** withheld as above²:

⇒ *Perform point of care testing (POCT) of ketones*

POCT ketones ≤ 1.5mmol/L

- ⇒ Proceed;
- ⇒ Hourly POCT ketones **intraoperatively**;
- ⇒ Two hourly POCT ketones **postoperatively** until eating and drinking.

POCT ketones > 1.5mmol/L

- ⇒ Perform venous blood gas (VBG)

VBG base excess +5 to -5

- Consider proceeding after discussion with diabetes team and DCCM;
- Start [Variable Rate Intravenous Insulin Infusion](#);
- Hourly POCT ketones **intraoperatively**;
- Two hourly POCT ketones **postoperatively** until eating and drinking.³

VBG base excess worse than -5

- Postpone surgery unless very urgent (e.g. [transplant](#))
- Discuss with diabetes team and DCCM
- **Treat euglycaemic DKA as a medical emergency** (see [euDKA management](#))

Notes

1. Minor surgery (including gastroscopy) is where fasting is minimised. If surgery/procedure requires bowel preparation, omit gliflozin the day before bowel prep starts and continue to omit until normal oral intake resumes post-operatively.
2. Above guide only applies if HbA1c <70 – further information [here](#) if this is not the case.
3. Day case patients can be discharged with POCT ketones >1.5 if VBG shows normal metabolic state and no nausea or vomiting

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1. Purpose of guideline

This document seeks to guide the **care of patients with diabetes who undergo a surgical procedure** and includes specific recommendations for patients undergoing **ophthalmic** surgery, **elective cardiothoracic** surgery and those with **end stage renal failure** (ESRF).

Please note that these are **guidelines only**. Some patients may require more individualised treatment. Note: *It is the prescribing physician's responsibility to communicate the patient's management plan to all relevant teams and clearly document plan in the patient's notes.*

This document does NOT apply to:

- Paediatric patients
- Pregnant women under-going labour and delivery (please refer to [Diabetes in pregnancy](#))
- Bariatric patients (please refer to [Diabetes – Bariatric Perioperative Management](#) guideline)
- Patients undergoing gastroscopy or colonoscopy
- Medical patients (Non-surgical) – see Diabetes team site and associated [guidelines](#)
- Medical emergency situations, e.g.
- Patients who have developed diabetic ketoacidosis (DKA)
- Patients with Acute Myocardial Infarction (MI)

Please contact the Diabetic Inpatient Nurse Specialist for advice in these cases

Note: Fluids, electrolytes and safety

In the protocols below, the authors have provided guidelines for a variety of infusions which include insulin, glucose, potassium and sodium chloride solutions. For some cases with heart failure, fluid overload pathology, pre-existing electrolyte disturbances, significant renal dysfunction, and potentially raised inter cranial pressure (ICP) there is a need for extra care to avoid fluid overload and electrolyte anomalies. Please do not disregard these other important patient factors when using the guidelines to manage the diabetes. Daily assessment of electrolytes and hemodynamic and volume status along with their diabetes control should be part of the care of patients under these guidelines and, assistance from more experienced medical staff should be sought if needed.

2. Definitions

Term	Definition
ABG	Arterial Blood Gas
AKI	Acute kidney Injury
Basal insulin	This includes intermediate and long acting insulin which controls CBG levels in between meals and during sleep
BHB	Beta-Hydroxybutyrate
CBG	Capillary blood glucose
CSII	Continuous SC Insulin Infusion pumps
DKA	Diabetic ketoacidosis
DM	Diabetes mellitus
DNS	Diabetic nurse specialist
EuDKA	Euglycemic diabetic ketoacidosis
gliflozin(s)	See SGLT2i below (Note: flozin = gliflozin = SGLT2i)
HbA1c	A haemoglobin A1c (Hb1Ac) test measures the amount of blood sugar

Term	Definition
	(glucose) attached to haemoglobin
HHS	Hyperosmolar hyperglycaemic state
ICP	Intracranial pressure
IV	Intravenous
MI	Myocardial infarction
OHA	Oral Hypoglycaemic Agent
ORDA	Operating Rooms Day of Admission area – preoperative area for the patients who are coming through Transition Lounge / day of surgery admission
POCT	Point-of-care-testing
SC	Subcutaneous
SGLT2i	SGLT2 Inhibitors = Sodium-glucose cotransporter-2 inhibitors = (gli)flozins New(er) oral diabetes medications that carry a risk of EuDKA. See Appendix 5
TPN	Total parenteral nutrition
VRIII (formerly GIK)	Variable rate intravenous insulin infusion. This terminology has replaced the traditional GIK (glucose-insulin-potassium). A VRIII may be used with different carrier fluids depending on patient needs. Please see Section 5.5 for further information.
VBG	Venous blood gas

3. Management in general

- Most patients may be able to continue their usual diabetes medications.
- If a variable rate intravenous insulin infusion (VRIII) is needed, it should be prescribed on the Diabetes Insulin Prescription and Blood Glucose Record (CR9194). Adjustment of scale (Scale A–D on last page of chart) requires that the infusion be **re-prescribed** on the chart. Any other fluid requirements should be prescribed separately.
- During VRIII, check **serum potassium at least daily** and more frequently as dictated by the clinical scenario.
- Hourly Capillary Blood Glucose (CBG) is usually required for patients on VRIII. However, in some circumstances two hourly CBG may be acceptable.
- **If CBG is below 4 mmol/L, this is hypoglycaemia**, please refer to **hypoglycaemia management** in the RMO handbook.
- At every episode of hypoglycaemia check infusion pump, line and solution for errors. **If hypoglycaemia persists after appropriate modification** of the infusion regime, **ask for specialist advice urgently**.
- Some patients receiving parenteral nutrition (PN) may require VRIII. **Additional glucose infusion is inappropriate** as these patients are having all their calorie needs supplied by PN.
- **Insulin should NOT be added to PN**. Further advice can be sought from Nutrition Support or Diabetic service via the Inpatient Diabetic Nurse Specialist (021466667) as it may be best managed with diabetes medication or intermediate-long acting insulin, rather than VRIII.

4. Pre-operative management

4.1 Targets for reducing post-operative complications

- Poor perioperative control ($\text{HbA1c} > 69 \text{ mmol/mol}$) is associated with higher incidence of surgical site infections, cardiovascular complications (e.g. myocardial infarction, atrial fibrillation), stroke, renal failure and increased length of stay.
- HbA1c is less associated with overall increased morbidity and mortality. The evidence for reduction in morbidity and mortality is associated with good immediate pre-, intra- and post-operative management.
- Aim for immediate perioperative CBG 8-12 mmol/L for patients with poorer control ($\text{HbA1c} > 69 \text{ mmol/mol}$) if more urgent surgery and time to optimise HbA1c is lacking (Wang & Luo et al, 2020).

4.2 Pre-assessment of the diabetic adult patient having elective surgery

4.2.1 Criteria for Diabetes Control categories

- Glycaemic control should be checked at the time of referral for surgery.
- All patients presenting to pre-assessment clinic with diabetes should have an HbA1c level within the last three months available, creatinine and electrolytes checked and an electrocardiograph (ECG).

Table 1. Criteria for diabetes control categories

Diabetes Control Category	HbA1c (mmol/mol)	Average CBG (mmol/L)	Comment
Excellent	50-55	7-9	Or as individualised target as per New Zealand Ministry of Health guidance.
Good	<64	<9	Without hypoglycaemia, management is optimal
Suboptimal	64-69	9-11	Needs improvement
Poor	70-74	11-12	Needs urgent improvement, <u>strongly consider delay</u> of non-urgent elective surgery
Very poor	≥75	12+	Needs urgent improvement, <u>strongly consider delay</u> of non-urgent elective surgery

- All patients should be given written instructions on management of their diabetic medications.** Printable forms can be found on the ADHB intranet: Hippo / A-Z Index / Anaesthesia Preoperative Assessment Services / Specialty and Comorbidity / Medical Comorbidities / Diabetes.
- If the insulin is **not** administered at home and needs to be administered on arrival to hospital, **please document Insulin prescription for day of surgery** on the Insulin Prescription chart (CR9194). These are available in the Pre-assessment clinic (see [Appendix 2](#)).

4.2.2 Very poorly controlled diabetes ($\text{HbA1c} \geq 75 \text{ mmol/mol}$)

- HbA1c should ideally be $< 70 \text{ mmol/mol}$ for elective cases. Delaying surgery should be considered for non-urgent elective cases if $\text{HbA1c} \geq 75 \text{ mmol/mol}$ with consideration of the

balance of risk from delaying surgery versus benefits of optimising diabetes control prior to clearance for surgery.

- In the case of patients with **very poorly** controlled diabetes, a referral to the Diabetic Service should be made and elective surgery delayed. In a small number of cases it may not be possible to improve glycaemic control before surgery, particularly if the surgery is semi-urgent or the reason for surgery is contributing to poor control. In these cases, surgery can proceed but the patient should be informed of the increased risk.
- *If **urgent** elective surgery, clear to proceed BUT flag as high-risk diabetes preoperatively and follow the plan for **high-risk diabetes mellitus pathway** (refer to [Appendix 1](#) for flow diagram Elevated HbA1c Pathway):
 - Refer to the in-patient Diabetes nurse / team once date for surgery known
 - Target CBG 8-12 mmol/L perioperative (higher end of normal range)
 - Consider VRIII if CBG >12 mmol/L on day of surgery
 - First on operating room list

4.2.3 Placement on surgical lists

- Diet-controlled only: any time on list is acceptable
- **Type 1 DM: 1st on list**
- **Type 2 DM:** Ideally **1st on list** if patient takes **insulin in addition to oral** diabetic medication and/or if prescribed SGLT2i

4.3 Pre- and Post-operative diabetes medication management

4.3.1 Table 2a. ORAL diabetic medicines: Pre- & Post-operative management

****For Cardiothoracic Surgery, please refer to [Section 6.1](#) in this document in addition to this table.**

Medication	Pre-op Dosing Schedule (Days before surgery)			Day of surgery (Day 0)		Day of surgery NOTES	Postoperative Action
	Day - 3	Day - 2	Day - 1	AM Surgery	PM Surgery		
Oral Hypoglycaemic Agents (OHAs)	Acarbose	✓	✓	✓	✗	✓ if eating breakfast	Restart when patient can eat and drink
	Metformin/ Combination DDP4 e.g. Galvumet (but note can cause GI upset if taken on empty stomach) See NOTES	✓	✓	✓	✓ unless Pt fits criteria for omission – see NOTES		OMIT only if: • Impaired renal function (eGFR <50mL/min/m ²) • Cardiac surgical patients • Procedures requiring contrast • Starvation period more than six hours post-operatively
	Pioglitazone	✓	✓	✓	Omit for Cardiothoracic	Omit for Cardiothoracic	For non-cardiothoracic surgery: take as normal on the day of surgery
	Sulfonylureas: Glipizide, Gliclazide, Glibenclamide	✓	✓	✓	✗	✗	Withhold or ↓ dose if oral intake reduced; Restart when Pt can eat and drink normally
	DPP4 inhibitors: Vildagliptin, Saxagliptin, Sitagliptin	✓	✓	✓	Omit for Cardiothoracic	Omit for Cardiothoracic	For non-cardiothoracic surgery: can continue but these can cause gastro-intestinal upset on empty stomach
	SGLT2 inhibitors: Dapagliflozin, Canagliflozin, Empagliflozin BEWARE other GLIFLOZINS – Pt could be on unfunded type Note: if taking for heart failure treatment only (i.e. non-diabetic)- omit day of surgery	Major surgery	✓	✗	✗	<ul style="list-style-type: none"> Measure blood glucose and ketones on admission. If POCT ketones elevated (>1.5mmol/L point of care or Beta-hydroxybutyrate (lab test) >1.5mmol/L) or if a GLIFLOZIN was NOT withheld as advised, take VBG to assess for acidosis see part 4.3.3.Pre-op advice SGLT2 Inhibitors. Surgery may need to be POSTPONED. Minor surgery (including gastroscopy) is where fasting is minimised If surgery/procedure requires bowel preparation, omit -gliflozin the day before bowel prep starts and continue to omit until normal oral intake resumes post-operatively. 	

4.3.2 Table 2b. INJECTABLE diabetic medicines - Pre- & Post-operative management of Insulin and Non-Insulin injectables

**For Cardiothoracic Surgery, please refer to [Section 6.1](#) in this document.

Do NOT follow this table. Do NOT follow the flowchart “Pre-operative Diabetes Management for Adults” in this document

	Medication	Day before surgery	Day of surgery (Day 0)		Day of surgery NOTES	Postoperative Action
			AM Surgery	PM Surgery		
Non-insulin injectables	Daily GLP-1 agonist Injectables: - Exenatide (5-10mcg SC bd), - Liraglutide (0.6 – 2.4 mg s/c daily; higher dose up to 3mg s/c daily if treating obesity)	✓	*	*	Omit daily injectable preparation Exenatide modified-release (Bydureon) 2mg ONCE weekly subcutaneous injection (soon to be withdrawn from NZ market) – continue, but be mindful that prolonged fasting can cause nausea and vomiting.	Restart when patient can eat and drink: <ul style="list-style-type: none">Minor surgery usually same day: if BD can have evening dose, or next day if daily.Major surgery usually day 3-5 post op Still risk of euglycemic DKA post-op if inadequate intake If delayed restart, seek advice from Diabetes team. Triggers for EuDKA: restricted dietary intake (e.g. fasted), surgery, dehydration and/or active infection
	Weekly GLP-1 agonist Injectable: Dulaglutide (Trulicity®) 1.5mg SC once weekly	✓	✓	✓	Weekly injection – continue, check CBG on admission. Dulaglutide (Trulicity®) is newly available and the only GLP-1 agonist currently funded, via special authority, in New Zealand Prolonged fasting can cause nausea and vomiting	Continue as usual
Insulin	Rapid Acting: Humalog®, Apidra®, Novorapid®	✓Normal dose night before surgery	*	*	•Withhold dose while NBM •Check CBG every 2 hours while NBM	•Restart when Pt can eat & drink with no nausea or vomiting •Restart normal dose at next meal
	Short Acting: Humulin R®, Actrapid®		*	*		
	Premixed Insulin: Humulin 30/70®, Penmix 30®, Mixtard 30®, Penmix 40®, Penmix 50®, Humalog Mix 25®, Novomix 30®, Humalog Mix 50®	✓Normal dose night before surgery	50% of usual morning dose (no breakfast) Do NOT self-drive if administered at home	50% of morning dose <u>with breakfast</u> Check CBG after 3 hours or if hypo symptoms	•Advise Pt re: hypoglycaemia management •Check CBG on admission to hospital •Check CBG every 2 hours while NBM	•While VRIII is used, continue as follows: 50% of usual SC dose of Premixed Insulin, 80% of usual SC dose for Intermediate & long acting - unless prone to hypoglycaemia, in which case reduce to 50% of usual SC dose •Increase back to 100% of usual dose when eating and drinking •Increase premixed insulin before a meal •VRIII – continue for two hours post increased sub cut insulin dose, then stop
	Basal Insulin (Intermediate and Long acting): Humulin NPH®, Protaphane®, Detemir (Levemir®), Glargin (Lantus®)	✓ If prone to hypoglycaemia give 80% of usual dose	80% of morning dose (no breakfast) Do NOT self-drive if administered at home	80% of morning dose <u>with breakfast</u> at home	•For both AM & PM surgery: If higher risk of hypoglycaemia (grazer or prone to lower CBG range) consider 50% of usual morning dose •Advise Pt re: hypoglycaemia management •Check CBG on admission to hospital	•Restart usual rate when eating and drinking – but not at bedtime as risk of overnight hypoglycaemia •VRIII should ideally continue 30 minutes after CSII restarted, check CBG 1 hourly until established back on usual regime. Acceptable range is CBG 4-15 mmol/L – contact Diabetes Service if CBG outside range
	Continuous S/C pump (CSII):	✓ Continue as usual	If sedation or general anaesthesia >1hr duration is planned discontinue pump (take note of usual rate) & start VRIII immediately		•High risk of DKA if no insulin administration perioperatively <ul style="list-style-type: none">Pt MUST be placed 1st on surgical listManagement must be individualised, especially while in CVICU / DCCM	•Restart usual rate when eating and drinking – but not at bedtime as risk of overnight hypoglycaemia •VRIII should ideally continue 30 minutes after CSII restarted, check CBG 1 hourly until established back on usual regime. Acceptable range is CBG 4-15 mmol/L – contact Diabetes Service if CBG outside range

4.3.3 Pre-op advice SGLT2 Inhibitors

Please note that this advice differs from the NZSSD document for periprocedural management for SGLT2i in terms of threshold for Blood POCT Ketone and BHB level indicating DKA. These are as per discussion with Diabetes Service and in line with advice as per RMO handbook.

Minor / Day stay procedures (i.e. prolonged fasting is NOT a risk)	Elective procedures with ward admission post-op	Major surgery: e.g. Cardiothoracic, major head and neck, all procedures with planned post op HDU / ICU
<ul style="list-style-type: none">SGLT2 inhibitor can be withheld on the day prior AND on the day of surgery/ procedure (i.e. one drug-free day before procedure).Fasting before and after the procedure should be minimised. Encourage adequate fluid intake water as per pre-operative fasting guideline, dehydration increases risk of EuDKA.If SGLT2 was only withheld on morning of surgery check POCT blood ketones before AND after procedure:<ul style="list-style-type: none">if <1.5mmol/L before procedure and patient well, may proceed after discussion with team;return to normal diet as soon as possible;if day case, do not discharge if post-operative ketones >1.5mmol/L;if post-operative ketones >1.5mmol/L, perform VBG or ABG to review metabolic state, if normal can discharge if no ongoing nausea and vomiting and feels well.	<ul style="list-style-type: none">The last dose of SGLT2 inhibitors should be at least 3 days pre-procedure (i.e. two drug free days before surgery date and day of surgery/procedure).For patients requiring bowel preparation, advise patients NOT to take SGLT2 inhibitors on the day bowel preparation starts and to continue withholding thereafter until after surgery then restart as per guideline (this excludes those for colonoscopy who have a different guideline).The elimination half-life for these drugs is 12-13 hours (wash out approximately 65 hours).Some are combination drugs with metformin.These patients may need the separate metformin replaced for a couple of days. Please discuss this with the patients GP or Diabetes specialist.	<p>For these procedures the ideal withholding time for SGLT2i /gliflozins would be 3 days; EXCEPT:</p> <ul style="list-style-type: none">WHERE for logistic reasons the delay might cause other risks for the patients, then discussion with the patient and the Surgery/ Anaesthesia Specialist about this is appropriate.This may mean that the 'gliflozin' is only withheld for the night before surgery, and active communication with the postoperative staff in the ICU about this must take place.Postop monitoring of acid base status, and blood ketone levels will be required.The scenario here is the risk of postponement of surgery due to lack of available HDU/ICU beds and continued or extended interruption of patients' diabetic management which may result in poor glycaemic control in the immediate perioperative period.

4.4 Continuous SC Insulin infusion (CSII) pumps – management for elective procedures

4.4.1 General approach to managing CSII pumps perioperatively

- There is still scope to individualise these patients management pre and post-operatively with input from in-patient diabetes team, usually these are highly compliant and motivated group of patients who are good at managing their own diabetes well.
- Patients on CSII do NOT take any long acting insulin so if there is any interruption to insulin delivery (e.g. if the cannula is blocked or dislodged) hyperglycaemia and then ketoacidosis can develop very quickly.**
- It is usually best for the patient to continue to self-manage their diabetes with the pump except:
 - If unconscious, confused or incapacitated e.g. sedation, general anaesthesia that prevents self-management
 - Procedure > 1 hour
 - Diabetic ketoacidosis (DKA)

4.4.2 CSII Summary Diagram - perioperative management

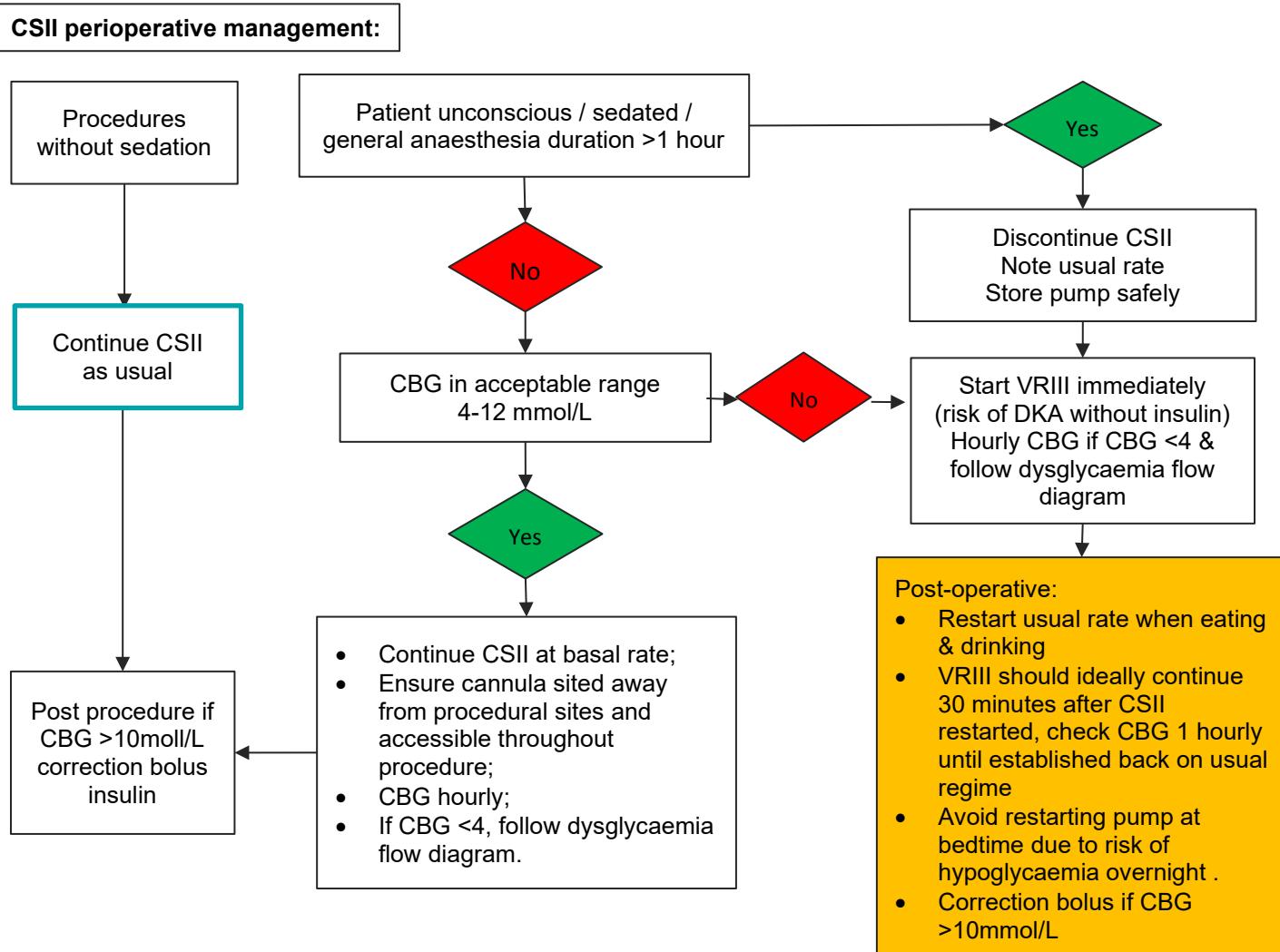
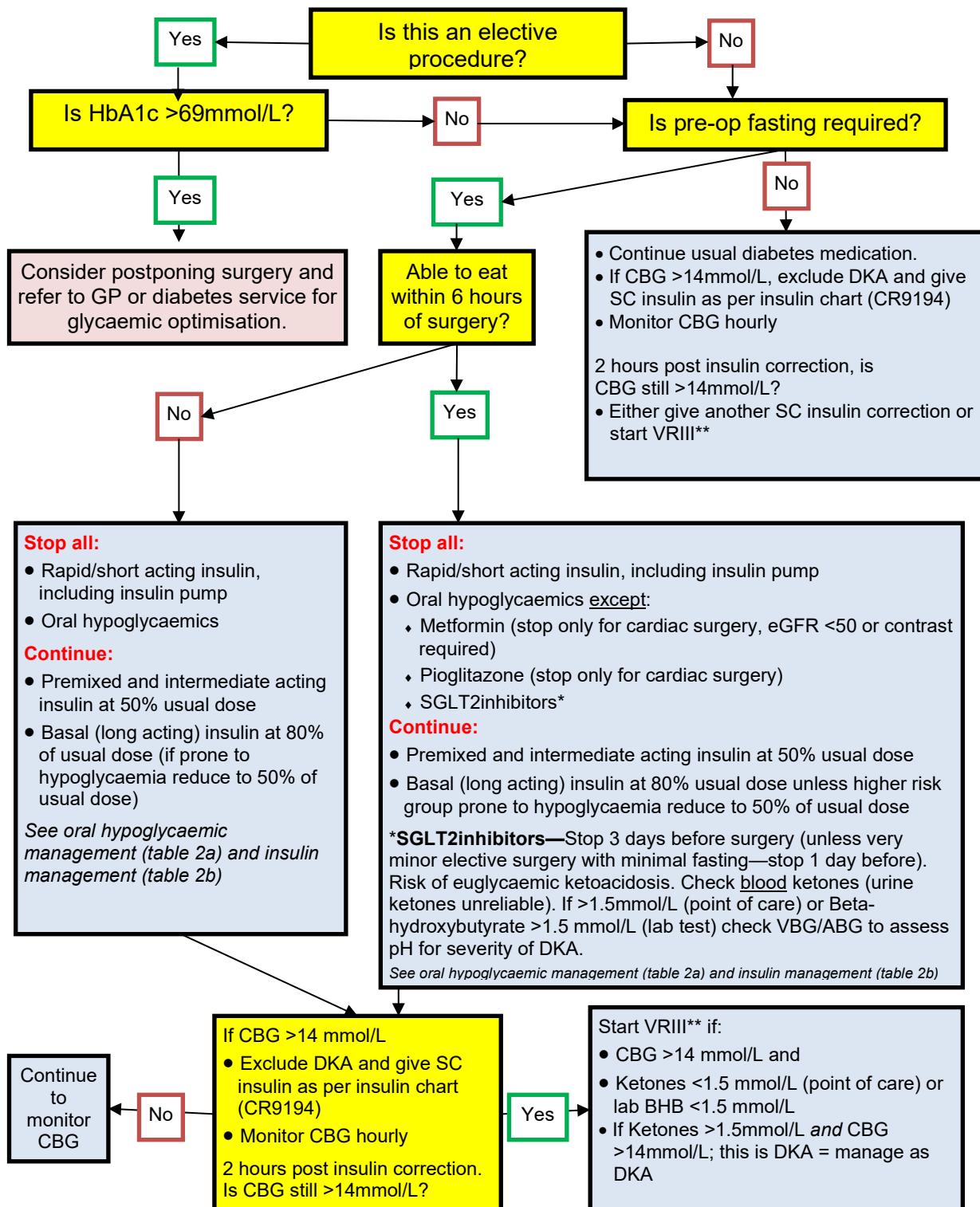


Figure 1. Continuous SC Insulin Infusion pump - perioperative management

4.5 Preoperative Diabetes Management for Adults – summary flowchart



*** if for cardiac surgery, refer to Anaesthetic Management plan, or contact anaesthetist prior to starting VRIII*

Notes:

- For prolonged fasting in the acute setting, treat as not able to eat within 6 hours after surgery
- If a patient has DKA—treat as per RMO handbook and inform Anaesthetist/Surgeon
- GLP-1 agonist injectable: Exenatide LAR (Bydureon) weekly—continue but be mindful prolonged fasting can cause nausea and vomiting.

Figure 2. Preoperative Diabetes Management for Adults

5. Day of surgery: Diabetes Care in the Operating Theatre Complex

5.1 On arrival to the pre-operative area or ORDA (from home or ward)

- If the patient normally takes basal insulin, this is usually continued throughout the perioperative period at 80% of the patients' normal dose (see [Table 2b](#)) unless prone to hypoglycaemic episodes (history of grazer or frequent hypoglycaemia episodes), in which case 50% of usual dose is advised.
- Patients on the ERAS pathway with well controlled Type 2 Diabetes (HbA1C < 64) may have a pre-operative CHO (carbohydrate) drink as for non-diabetic patients.
- **All diabetic patients** should have a CBG level checked and documented on arrival to preop area or ORDA (Including those on GLP-1 injectables).
- Acceptable range is a CBG of **6 - 14 mmol/L**
- If the patient **did** self-administer insulin at home or on the ward and CBG is <6.0mmol on arrival to ORDA or preop area, re-check half-hourly and consider glucose IV infusion or bolus 100mls 10% glucose.
- If the patient **did not** have insulin at home or ward on the day of surgery as per [Table 2b](#) (Note: *Cardiothoracic Surgery follows different rules as per [Section 6.1](#)*), it should be administered in ORDA or preop area, as long as these steps are followed:
 - if CBG is **4.0 - 5.9 mmol/L => check CBG half-hourly**; Note: when **CBG <6 mmol/L do not administer insulin in ORDA** without discussion with relevant list anaesthetist;
 - if a Type 1 diabetic has missed their basal insulin, then a VR III should be started.
 - if CBG is outside of the range of 4-14 mmol/L, please refer to the flowchart in [Section 5.3](#).

5.2 Perioperative risks for patients on SGLT2 inhibitors

- SGLT2 inhibitors carry a small but definite risk of severe diabetic ketoacidosis (DKA) in diabetic patients. DKA may be associated with near normal or only mildly elevated blood glucose levels (i.e. euglycaemic ketoacidosis [EuDKA]).
- EuDKA risk is increased 7 fold with SGLT2i compared to other diabetes drugs (Blau et al., 2017)
- The risk of EuDKA is increased in **some specific patient groups**. These especially include those with Type 2 diabetes that is *poorly controlled* ($HbA1C >69\text{mmol/mol}$).
- Patients **exposed to prolonged fasting, restricted dietary intake, bowel preparation, dehydration, reduction in insulin use, or intercurrent illness (particularly infection), have an increased risk of EuDKA**.
- Patients with $HbA1c >75\text{ mmol/L}$ are at greater risk.
- Management of EuDKA is with rehydration, VR III and electrolyte correction. Surgical patients with confirmed EuDKA should be considered for Critical Care monitoring.

Note: Non-diabetic patients who have been prescribed SGLT2 inhibitors for **heart failure** should follow the same guidance as the diabetic population until further evidence is available to clarify whether they are at lower risk of EuDKA or not.

5.2.1 Actions on arrival to the preoperative area or ORDA (elective or acute cases, on SGLT2i)

- If the patient is **well** and has withheld SGLT2i appropriately (see [Table 2a](#)), proceed to surgery as planned
- If the patient is **well** and has **NOT withheld SGLT2i appropriately** (see [Table 2a](#)):
 - measure blood **glucose**, blood **ketones** or **BHB**, and ABG or VBG to assess base excess, AND
 - follow the advice in [Section 5.2.2](#) below.
- If the patient is **unwell**:

- strongly consider postponing non-urgent acute or elective procedures, AND
- measure blood **glucose** and blood **ketones or BHB**, AND
- follow the advice in [Section 5.2.2](#) below.

5.2.2 What to do if SGLT2i was not withheld appropriately

- If SGLT2 inhibitor has not been stopped appropriately for patients with **HbA1c >69** (indicates insulin deficiency), even if ketones are normal, consider postponing surgery as this is a **higher risk group for EuDKA**
- If HbA1c <70 pre-operative and if POCT blood ketones are <1.5 mmol/L or lab tested BHB <1.5 mmol/L
 - proceed if appropriate (see below as per different scenarios); AND
 - consider **hourly blood glucose** and blood **ketone** testing during procedure and **2 hourly following procedure** until eating and drinking normally
- If POCT blood ketones are elevated >1.5 mmol/L (or lab tested BHB >1.5 mmol/) follow the advice in [Section 5.2.4](#)

5.2.3 Decision to proceed with surgery (or not) in the context of SGLT2 medications

- Patients presenting for time-sensitive surgery (e.g. cancer) or acute surgery **must have a multidisciplinary preoperative discussion** with Anaesthesia, Surgical and Critical Care services. **This situation should be rare**, and every effort should be made to allow time to withhold the gliflozins. The kinds of cases in this category are true acute cases and especially transplant cases. It will also include cases where arrangements for surgery are complex and hard to duplicate easily and the best option is to proceed.
- Proceed only if surgery is time critical or logistics dictate, and metabolic state has been thoroughly reviewed.
- Manage with a clear post-operative plan in place

5.2.4 Management approach to ketones and acid-base status

- **Management depends on the urgency and complexity** factors such as: the risk of the procedure, patient comorbidities, surgical factors, HbA1c, blood ketones and base excess.
- *Important considerations:*
 - Check blood ketones as urinary ketones are unreliable.
 - Finger prick ketone meters (if available) OR
 - BHB or plasma ketones sent to the lab can take 1 hour or more.
- If the patient is **well**, and proceeding with surgery is being considered, review the ABG or VBG to assess for metabolic acidosis – there are 3 typical scenarios:
 - (1) **Normal ketones and no metabolic acidosis** (POCT ketones <1.5mmol/L AND base excess *better than -5*) → consider proceeding with surgery after discussion with diabetes team and DCCM. Measure hourly POCT blood ketones or BHB during procedure, and 2 hourly post procedure until eating and drinking normally. Perioperative glucose and VR III (in most cases requiring additional potassium) may reduce the risk of EuDKA.
 - (2) **Ketosis and no metabolic acidosis** (POCT ketones >1.5mmol/L, but base excess *better than -5*) → Discuss with DCCM and diabetes team. Ketosis without acidosis may reflect starvation, particularly if HbA1c <75mmol/L. Consider proceeding with VR III (additional glucose 5% or 10% +/- potassium to keep CBG >5 mmol/L) and adequate fluid management (avoid dehydration).

- (3) **Ketosis with metabolic acidosis** (POCT ketones >1.5mmol/L AND base excess worse than -5) → Strongly consider postponing surgery unless very urgent. Involve Critical Care and diabetes team. Refer to the [Section 5.2.5](#) as this is probably Euglycaemic Diabetic Ketoacidosis (EuDKA).

5.2.5 Euglycaemic Diabetic Ketoacidosis (EuDKA): Diagnosis and Management

EuDKA is a medical emergency. Suspected EuDKA requires immediate attention – please follow advice below for diagnosis and management. Seek senior support if unsure and/or to escalate as required.

If the POCT blood ketones are >1.5mmol/L or BHB >1.5mmol/L in patients who have been on an SGLT2i - the patient must have an urgent ABG or VBG to measure base excess, if this test has not already been done.

Please note that this advice differs from the NZSSD document for periprocedural management for SGLT2i in terms of threshold for Blood POCT Ketone and BHB level indicating DKA. These are as per discussion with Diabetes Service and in line with advice as per RMO handbook.

Euglycaemic Diabetic Ketoacidosis (EuDKA) symptoms & signs

- Abdominal pain, nausea, vomiting or fatigue
- Metabolic acidosis (anion gap metabolic acidosis)
- pH <7.3
- Base excess worse than -5mmol/L
- Bicarbonate <15mmol/L
- Anion gap >12 mmol/L (albumin corrected)
- Normal or mildly increased plasma glucose (but <14mmol/L)
- Increased POCT ketones >1.5 mmol/L or BHB >1.5mmol/L (lab test) – Note: Normal range for ketones <0.6 mmol/L and BHB <0.3 mmol/L - though these may be elevated due to fasting.

Note that:

- Normal blood glucose levels do not exclude the diagnosis
- Normal urine ketones do not exclude the diagnosis. You need to follow blood ketone levels when dealing with the possibility of EuDKA).
- Lactic acidosis is an important differential diagnosis, but may also precipitate EuDKA

If any of the above features are present, EuDKA is likely, so **please discuss with the diabetes team and Critical Care**. Management is with rehydration, VRIII, electrolyte correction. Some patients may need invasive monitoring.

Management of EuDKA

- STOP SGLT2 inhibitor;
- Initial management is fluid resuscitation with a balanced / isotonic crystalloid (e.g. Plasmalyte 148) 1–1.5 L/hr (for the first 1-2 hours);
- Immediately commence VRIII
- Add glucose 5% or 10% if CBG <15 mmol/L with IV insulin titration - check CBG hourly;
- Aim K+ (potassium) >3.3 mmol/L, supplementation likely to be required;
- Aim of resuscitation is to resolve the high anion gap metabolic acidosis;
- **Destination after post anaesthesia care unit (PACU):** Patients with confirmed EuDKA should be strongly considered for admission to HDU. In rare instances, if the patient is

considered well enough to go to the ward (EWS<6 and DCCM agree appropriate), please alert the surgical team and the diabetes service (in hours) or gen med service (out of hours).

5.3 Management of dysglycaemia pre- and intra-operatively

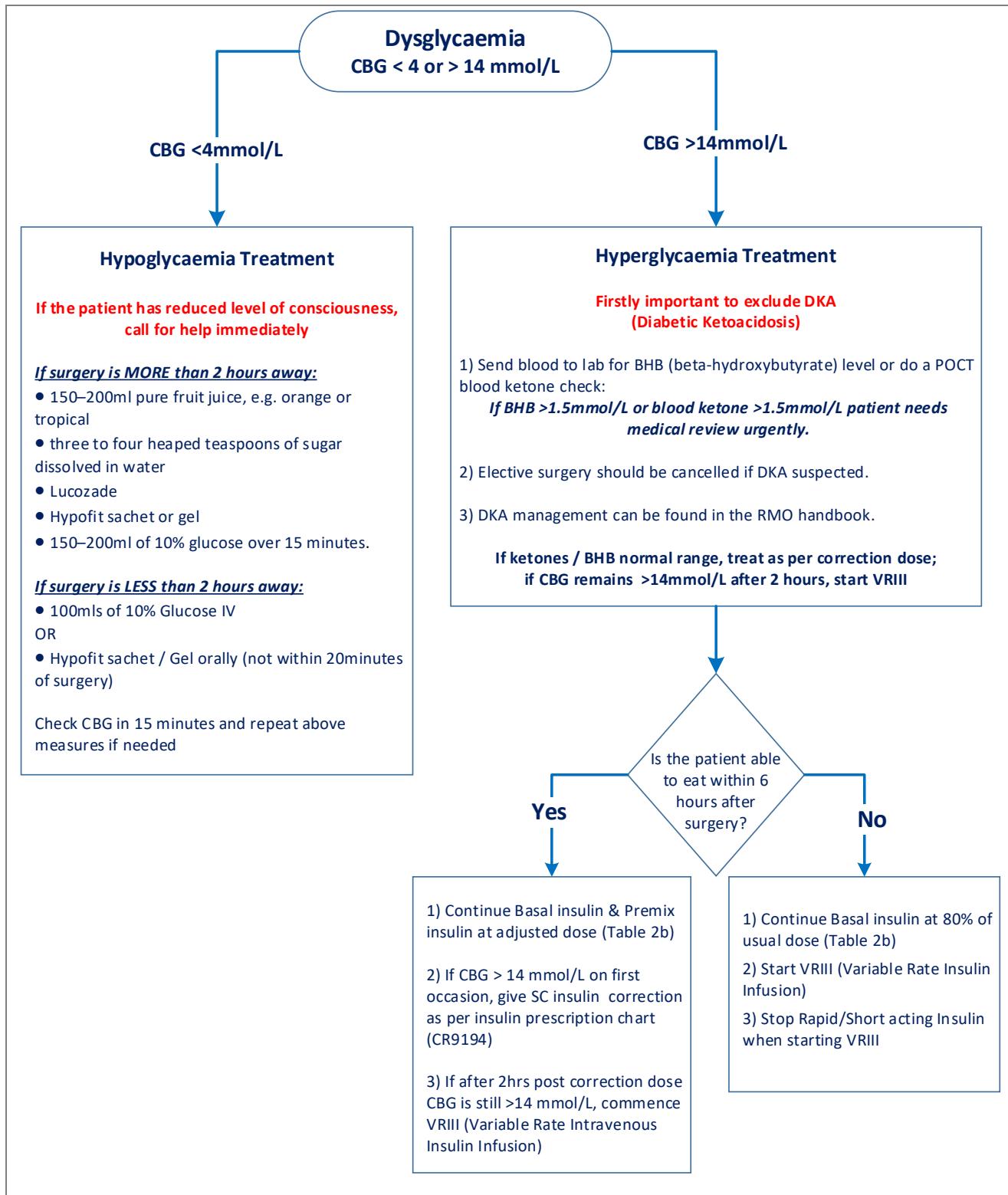


Figure 3. Pre- and intra-operative management of dysglycaemia

5.4 Intra-operative management

- Aims of intraoperative management are to provide good glycaemic control and normal electrolyte concentrations. **CBG of 6-12 mmol/L is acceptable**. If under 6 mmol/L but greater than 4 mmol/L consider more frequent screening than hourly or give glucose containing Intravenous fluid. If greater than 12 mmol/L consider starting VRIII and if greater than 14 mmol/L then manage as per the [dysglycaemia diagram](#) above.
- Hourly CBG while patient unconscious or sedated.
- Optimal **multimodal analgesia** and **anti-emetic prophylaxis** should be provided with the aim of diabetic patients returning to a normal diet as soon as possible.
- A **CBG level** should be taken **prior to induction** and **monitored hourly** throughout the procedure.
- Management of **dysglycaemia** depends on when the patient will be able to eat post operatively. Please see instructions below.

5.4.1 Patients who can eat within six hours after surgery

- **CBG >14 mmol/L:**
 - Correct with SC insulin as per Diabetes Insulin Prescription and Blood Glucose Record (CR9194);
 - DKA needs to be excluded: if POCT ketones are elevated i.e. >1.5 mmol/L (or if lab BHB >1.5mmol/L. *Note: this test takes >1 hour to process in lab*): this may indicate that the patient has DKA and elective surgery should be postponed. If surgery cannot be postponed, refer to DKA management in the RMO handbook. If surgery is already underway, VRIII should be commenced intra-operatively;
 - If ketones/ BHB are normal recheck CBG after two hours, if it remains >14 mmol/L then a VRIII should be started.
- **CBG <4 mmol/L:**
 - Give 100 mL of 10% glucose IV stat
 - Recheck CBG in 10 to 15 minutes and repeat glucose bolus if needed

5.4.2 Patients who cannot eat within the next six hours after surgery

- **CBG >14 mmol/L:**
 - Start a VRIII as per the Diabetes Insulin Prescription chart
 - DKA needs to be excluded: if POCT ketones are elevated i.e. >1.5 mmol/L (or if lab BHB >1.5mmol/L. *Note: this test takes >1 hour to process in lab*): this may indicate that patient has DKA and elective surgery should be postponed. If surgery cannot be postponed, refer to DKA management in the RMO handbook. If surgery is already underway, VRIII should be commenced intra-operatively.
 - Monitor CBG hourly and change VRIII as per the VRIII scale on Insulin Chart.
- **CBG <4 mmol/L:**
 - Given 100 mL of 10% glucose IV stat
 - Recheck CBG in 10 to 15 minutes and repeat glucose bolus if needed.

5.5 Variable rate intravenous insulin infusion (VRIII)

A VRIII is an effective method of treating hyperglycaemia in vulnerable people with diabetes. Hypokalaemia is a common complication and all patients on IV insulin need regular K monitoring. Additional IV glucose infusion is often commenced once the CBG readings are <15mmol/l so as to allow continuation of the VRIII without causing hypoglycaemia.

5.5.1 Indications for VRIII

- Fasting patients, expected to have a long fasting period (more than one pre-op or post op meal missed) with a CBG >14 mmol/L;
- Patients with a CBG >14 mmol/L; and the patient is critically unwell, vomiting or unable to eat and drink;
- POCT ketones >1.5 mmol/L or BHB >1.5 mmol/L *and* CBG is <14mmol/L – i.e. EuDKA (see [Section 5.2.5](#)). POCT ketones >1.5 mmol/L or BHB >1.5 mmol/L *and* CBG is <14mmol/L – i.e. EuDKA see [Section 5.2.5](#) for management; **For patients with DKA (as opposed to EuDKA) or HHS please seek advice from the Diabetes service urgently;**
- Patients who remain hyperglycaemic (CBG >14 mmol/L) two hours after SC insulin correction;
- Patients unable to tolerate oral intake e.g. prolonged ileus, severe nausea and vomiting;
- Please see [Section 6.4](#) for advice on end stage renal failure patients;
- Refer [Appendix 4](#) for VRIII - set up instructions.

5.5.2 Prescribing instructions

- If the patient normally takes Basal Insulin, continue this throughout the perioperative period at 80% of their normal dose (see [Table 2b](#)). A VRIII can be given on top of the patient's Basal Insulin.
- Prescribe patient's adjusted Basal subcutaneous insulin on the Diabetes Insulin Prescription and Blood Glucose Record (CR9194).
- Determine the patients usual daily insulin requirement.
- Use the table on the Diabetes Insulin Prescription and Blood Glucose Record (CR9194) to determine which scale of IV insulin infusion the patient needs.
- Monitor CBG hourly and change the insulin prescription scale if needed (see Diabetes Insulin Prescription).
- Use the [table](#) below to determine carrier fluid.

5.5.3 Carrier fluid choices

Clinical Condition	Fluid	Infusion Rate
General - Default fluid	glucose 5% + NaCl 0.45% + KCl 20 mmol	80 mL/h
Hyperkalaemia	glucose 4% + NaCl 0.18%	80 mL/h
Fluid overload	glucose 5% + NaCl 0.45% + KCl 20 mmol	40 mL/h
End Stage Renal failure patients (see Section 6.4)	glucose 10% (only start if CBG ≤ 10 mmol/L)	40 mL/h

5.5.4 Monitoring while on VRIII

- Monitoring should be done as per the Diabetic Insulin Prescription and Blood Glucose Record (CR9194).
- All fasting patients on insulin should have hourly CBG levels taken.
- If there is a problem with hypo or hyperglycaemia, please remember to check the delivery equipment. If there is no delivery error, consult the diabetic prescription chart and consider changing the insulin prescription scale.

6. Special Perioperative Scenarios

6.1 Cardiothoracic surgery

The following shows the **perioperative management** of **insulin, gliflozins and other hypoglycaemic medications** for patients undergoing cardiothoracic surgery:

6.1.1 Morning Elective List

- Normal / usual regime day before surgery;
- **No Insulin or oral hypoglycaemic drugs on morning of surgery** (note: SGLT2 inhibitors have to be stopped **three DAYS** before surgery);
- GLP-1 injectables (weekly) can be continued but needs CBG checked on admission and note prolonged fasting can cause nausea and vomiting;
- Check CBG every hour from 7am;
- Contact anaesthetist if CBG <5 mmol/L or >15 mmol/L;
- Anaesthetist will document if/when Nutricia Preop will be given;
- Start Insulin in Operating Room.

6.1.2 Afternoon Elective List

- Normal regime day before surgery;
- No oral hypoglycaemic drugs on morning of surgery (Note: SGLT2 inhibitors have to be stopped **three DAYS** before surgery, with the exception of very minor elective surgery with minimal fasting where they can be stopped one day prior);
- GLP-1 injectables (weekly) can be continued but needs CBG checked on admission and note prolonged fasting can cause nausea and vomiting;
- No breakfast;
- No short acting Insulin to be given;
- 50% of usual morning premixed or basal (long acting) SC Insulin;
- Check CBG every two hours from time of SC Insulin dose, and hourly if any episode of hypoglycaemia is detected;
- Contact anaesthetist if CBG <5 mmol/L or >15 mmol/L;
- Anaesthetist will decide if/when Nutricia Preop will be given;
- Start Insulin in Operating Room.

** SGLT2 Inhibitors are Dapagliflozin, Canagliflozin, Empagliflozin.

** SGLT2 Inhibitors can cause Euthyglycemic DKA and the risk is enhanced perioperatively.

** The Anaesthetic senior medical officer (SMO) or registered medical officer (RMO) can change any individual patients management from the above guidelines if clinically appropriate.

NOTE: GLP-1 injectables (weekly) can be continued but needs CBG checked on admission and restrict fasting time to six hours (prolonged fasting can cause nausea and GIT upset)

***GLP-1 agonist injectable : Exenatide LAR (Bydureon) weekly injection – continue but mindful of prolonged fasting can cause nausea and vomiting

6.1.3 Acute & time-sensitive surgery including transplant cases

Transplants are carefully managed preoperatively, and this care may well include ongoing gliflozin therapy. **There will be no time available to withhold the gliflozin prior to surgery** and the operation will proceed despite being on a flozin/SGLT2i.

The referring clinician should **highlight that the patient is on a flozin/SGLT2i to the anaesthesia team** who can then **inform the relevant OR & ICU team members**.

The **referring clinician must ensure that the patient has the pre op blood glucose, blood ketone and VBG** to assess acid-base status as part of the referral for risk assessment.

There will be other acute non-transplant patients taking gliflozins which will have to be managed as per the transplants above.

There will also be rare cases where logistic considerations require cases to go ahead without time being available to withhold gliflozins as per the elective guidelines above. This situation should be **rare and exceptional** and the decision to proceed should be made only after a careful discussion between the Anaesthesia and Surgical SMOs.

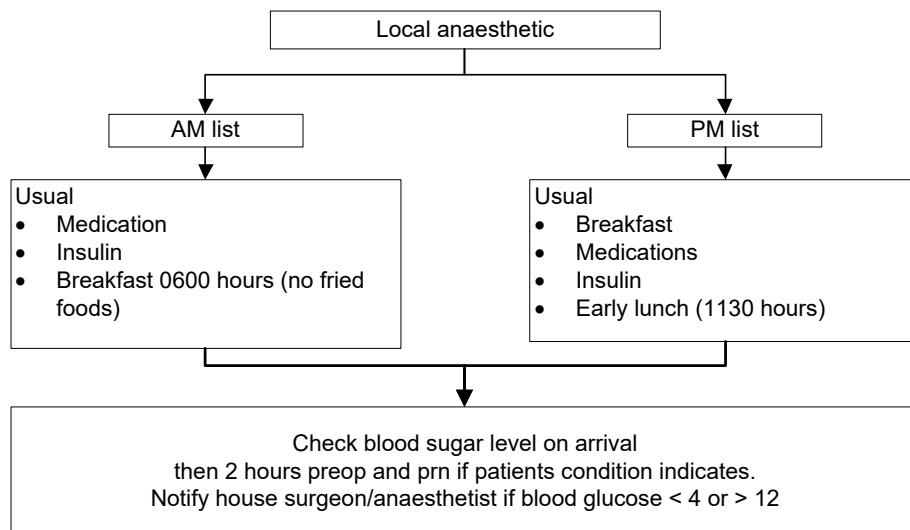
The immediate preoperative and intraoperative gliflozin-related monitoring will be as for other acute contexts mentioned above, namely regular acid base status assessment and regular measurement of glucose and ketones in blood.

Please use [Section 5.2.5](#) as a basis for management of EuDKA as needed.

6.2 Ophthalmology surgery

The following **local anaesthetic** flowchart shows the perioperative management of diabetic patients undergoing ophthalmologic surgery.

Note: The patients are not nil by mouth prior to the procedure and are NOT having sedation or general anaesthetic.



Perioperative ophthalmology diabetic guidelines - for patients requiring **sedation or general anaesthetic** please follow guideline as for other perioperative management (see [Section 4](#) and [Section 5](#)).

6.3 Bariatric surgery

Please refer to the Anaesthesia Department Guideline (2022) [Diabetes – Bariatric Perioperative Management](#) for specific guidance tailored to diabetic patients undergoing bariatric surgery in Auckland City Hospital and Greenlane Surgical Unit.

6.4 End Stage Renal Failure (ESRF)

Perioperative medication management for renal patients with diabetes

Patients with chronic kidney disease with eGFR ≤ 20 mL/min or on dialysis have fewer requirements for insulin, and most of them are on no or minimal oral hypoglycaemic agents. These patients are at high risk for hyperkalaemia and fluid overload due to poor renal function. As a result, the perioperative diabetes management for these patients differs from other patient populations.

Please act in accordance with the following principles:

6.4.1 For elective procedures and fasting less than six hours:

- The patient's regular **SC insulin (premixed or basal insulin)** can be continued prior to surgery at 50-80% of the usual dose and at the usual time (see [Table 2b](#)).
- Supplemental (PRN) subcutaneous short acting insulin can be used if CBG is >12 mmol/L, suggested prn insulin doses as per table in the [Diabetes Insulin Prescription and Blood Glucose Record](#).

6.4.2 For elective procedures and fasting greater than six hours:

- For patients with poorly controlled diabetes (**CBG ≥ 15 mmol/L**) and who are likely to have prolonged fasting ($>$ six hours):
 - Continue patient's regular **basal insulin at 80% of usual dose**
 - STOP premixed insulin and short/rapid acting insulin and
 - START a VRIII
- Scale A is the default scale for renal patients** (as per Diabetic insulin prescription chart).

6.4.3 Concurrent IV fluids:

- IV glucose SHOULD ONLY BE GIVEN IF CBG ≤ 10 mmol/L:
 - 500 mL of glucose 10% at 40 mL/h (or lower if fluid overloaded)
 - Potassium infusion **SHOULD NOT BE GIVEN** unless at the discretion of the renal registrar
- Helpful tip: Consider stopping both insulin and glucose infusions when CBG ≤ 8 mmol/L

6.5 Steroid-related hyperglycaemic pathway

Hyperglycaemia in hospital inpatients is associated with increases in mortality, length of stay, infection rate and likelihood of Intensive Care Unit (ICU) admission.

- Steroids are well recognised as a major cause of in-hospital hyperglycaemia. In fact, hyperglycaemia develops in over half of all of inpatients who are prescribed steroids.
- Screening for hyperglycaemia should be considered in all patients receiving steroids. Refer to the 'Steroid-related Hyperglycaemic Flow Chart' in the [RMO Handbook](#) for specifics of screening and treatment.
- At a minimum, we advocate for screening in any patient with one or more of the following risk factors:
 - Known diabetes or pre-diabetes
 - Previous gestational diabetes
 - Previous steroid-induced hyperglycaemia

- Total steroid dose >20 mg prednisone equivalent per day
- Length of steroid treatment >five days
- Age >55
- Body Mass Index (BMI) >30
- Concurrent use of medications known to raise blood sugars (e.g. calcineurin inhibitors or mycophenolate)
- Patients with multiple comorbidities
- Post-surgical patients

7. Post-operative management

7.1 Prior to arrival to PACU

- Document the most recent CBG and instructions for CBG intervals in PACU on the anaesthetic record;
- Document a plan in the clinical notes for Diabetes medication management including the plan to discontinue VRIII if started pre-operatively (restart usual medication once the patient is eating and drinking as normal with no nausea and vomiting, otherwise continue VRIII). Please refer to [Section 7.3: Special Post Op Scenarios](#) below for **patients on SGLT2i or on CSII** as they will require special post op care;

For patients with **pre-operative poor control (HbA1C ≥ 75mmol/mol)**:

- Refer the patient to the inpatient Diabetes nurse / team for follow-up,
- Target CBG of 8-12 mmol/L perioperatively (higher end of normal range),
- Start VRIII if CBG >12 mmol/L persistently perioperatively;

7.2 In PACU or the ward

- Monitor CBG according to instructions. Ensure patients on **insulin** have a completed Diabetes Insulin Prescription and Blood Glucose record [CR9194](#) to enable administration of SC insulin;
- **Restart** usual medication once patients eating and drinking as normal, with no nausea and/or vomiting. Otherwise continue as per "[Not able to eat within 6 hours postoperatively](#)".
- If on **VRIII**, continue for **two hours** after diabetes medications are restarted (orals and insulin sc)
 - For **Dysglycemia (CBG <4 or >14 mmol/L)** manage as per [Insulin prescription chart](#) (CR9194) and RMO handbook – please contact anaesthetist/team for management
 - For patients on **SGLT2 inhibitors** please see [Section 7.3.2. Post-operative management of SGLT2 inhibitors](#).

7.3 Special Post-operative Scenarios

7.3.1 CSII (Continuous SC Insulin Infusion pump)

- Restart pump usual rate when eating & drinking and when capacity to self-manage established;
- VRIII should ideally continue 30 minutes after CSII restarted, check CBG 1 hourly until established back on usual regime;
- Avoid restarting pump at bedtime due to risk of hypoglycaemia overnight;
- Correction bolus if CBG >10mmol/L.

7.3.2 Post-operative management of SGLT2 Inhibitors (gliflozins)

- Every patient on gliflozin, who had any surgery other than minor/day stay, must get a **post-op CBG and POCT ketone measurement** on arrival in PACU. See [Section 5.2.4](#) re: how to interpret results (ABG or VBG will be needed if ketones >1.5mmol/L);
- Patients who withheld SGLT2i as per instruction are managed as per postoperative section of [Table 2a](#);
- Patients on SGLT2 inhibitors who did **not** withhold the gliflozin prior to undergoing elective or emergency surgery are at risk of EuDKA (even if post-op ketones <1.5mmol/L), especially if the patient has inadequate oral intake post-op. **The Diabetes Service (in hours) or the General Medicine service (out of hours) should be alerted if the patient is transferred to the ward. If the EWS is raised, the PaR team should be alerted.** Strict **monitoring of glucose and ketones every two hours** is recommended until normal diet has resumed, withhold SGLT2i until normal diet and fluid intake resumes, manage with VRIII as appropriate and CBG dictates; If the patient is well enough to go to the ward with close monitoring in place, please alert the
- Lactic acidosis is an important differential diagnosis but may also precipitate EuDKA;
- If the POCT blood ketone level is >1.5 mmol/L or BHB >1.5mmol/L (lab test) in an unwell or post-operative patient, who had been on an SGLT2 inhibitor, the anaesthetist (if in PACU) or the treating medical officer (if on ward) should be contacted to perform an **urgent** ABG or VBG to measure the base excess, see [Section 5.2.5](#) for further advice
- For all postoperative patients on SGLT2i:
 - Be aware of possible triggers for EuDKA such as: restricted dietary intake, dehydration and active infection.
 - Restart SGLT2 inhibitors when patient can eat and drink as normal:
 - Minor surgery usually after one day;
 - Major surgery usually day 3-5 post op, once normal diet and fluid intake been resumed;
- Patients who have day surgery/procedures should only recommence SGLT2 inhibitor if on full oral intake. Consider delaying recommencement of SGLT2 inhibitor for a further 24 hours but also consider potential for hyperglycaemia.

8. Supporting evidence

- Association of Anaesthetists of Great Britain and Ireland. (2015). Peri-operative management of the surgical patient with diabetes. *Anaesthesia*, 70, 1427-1440. <http://onlinelibrary.wiley.com/doi/10.1111/anae.13233/full>
- Australian Diabetes Society & New Zealand Society for the Study of Diabetes. (2022). *Alert Update July 2022. Periprocedural Diabetic Ketoacidosis (DKA) with SGLT2 Inhibitor use in people with diabetes*. <https://diabetessociety.com.au/position-statements-guidelines-type-2.asp>
- Barker, P., Creasey, P. E., Dhatariya, K., Levy, N., Lipp, A., Nathanson, M. H., Penfold, N., Watson, B., & Woodcock, T. (2015). Peri-operative management of the surgical patient with diabetes 2015: Association of Anaesthetists of Great Britain and Ireland. *Anaesthesia*, 70(12), 1427–1440. <https://doi.org/10.1111/anae.13233>
- Blau, J. E., Tella, S. H., Taylor, S. I., & Rother, K. I. (2017). Ketoacidosis associated with SGLT2 inhibitor treatment: Analysis of FAERS data. *Diabetes/Metabolism Research and Reviews*, 33(8), 10.1002/dmrr.2924. <https://doi.org/10.1002/dmrr.2924>
- Centre for Perioperative Care. (2022). *Guideline for perioperative care for people with diabetes mellitus undergoing elective and emergency surgery*. <https://www.cpac.org.uk/guidelines-resources-guidelines-resources/guideline-diabetes>
- DeFelice, N., & Thompson, R.E. (2016). Diabetes and hyperglycemia in the surgical setting. *Hospital Medicine Clinics*, 5(2), 189–204. <https://doi.org/10.1016/j.ehmc.2015.11.006>
- Dhatariya, K.K. (2022). The management of diabetic ketoacidosis in adults—An updated guideline from the Joint British Diabetes Society for Inpatient Care. *Diabetic Medicine*, 39(6), e14788. <https://doi.org/10.1111/dme.14788>

- Douros, A., Lix, L. M., Fralick, M., Dell'Aniello, S., Shah, B. R., Ronksley, P. E., Tremblay, É., Hu, N., Alessi-Severini, S., Fisher, A., Bugden, S. C., Ernst, P., Filion, K. B., & Canadian Network for Observational Drug Effect Studies (CNODES) Investigators (2020). Sodium-Glucose Cotransporter-2 Inhibitors and the Risk for Diabetic Ketoacidosis : A Multicenter Cohort Study. *Annals of Internal Medicine*, 173(6), 417–425. <https://doi.org/10.7326/M20-0289>
- Joint British Diabetes Societies for Inpatient Care. (2022). *The hospital management of hypoglycaemia in adults with diabetes mellitus*. Association of British Clinical Diabetologists. <https://abcd.care/resource/jbds-01-hospital-management-hypoglycaemia-adults-diabetes-mellitus>
- Joshi, G. P., Chung, F., Vann, M. A., Ahmad, S., Gan, T. J., Goulson, D. T., Merrill, D. G., Twersky, R., & Society for Ambulatory Anesthesia (2010). Society for Ambulatory Anesthesia consensus statement on perioperative blood glucose management in diabetic patients undergoing ambulatory surgery. *Anesthesia and analgesia*, 111(6), 1378–1387. <https://doi.org/10.1213/ANE.0b013e3181f9c288>
- Moghissi, E. S., Korytkowski, M. T., DiNardo, M., Einhorn, D., Hellman, R., Hirsch, I. B., Inzucchi, S. E., Ismail-Beigi, F., Kirkman, M. S., Umpierrez, G. E., American Association of Clinical Endocrinologists, & American Diabetes Association (2009). American Association of Clinical Endocrinologists and American Diabetes Association consensus statement on inpatient glycemic control. *Diabetes Care*, 32(6), 1119–1131. <https://doi.org/10.2337/dc09-9029>
- Musso, G., Saba, F., Cassader, M., & Gambino, R. (2020). Diabetic ketoacidosis with SGLT2 inhibitors. *BMJ (Clinical research ed.)*, 371, m4147. <https://doi.org/10.1136/bmj.m4147>
- New Zealand Ministry of Health. (2018). *Cardiovascular disease risk assessment and management for primary care*. <https://www.health.govt.nz/publication/cardiovascular-disease-risk-assessment-and-management-primary-care>
- New Zealand Ministry of Health. (2022). *Diabetes*. <https://www.health.govt.nz/our-work/diseases-and-conditions/diabetes>
- New Zealand Society for the Study of Diabetes. (n.d.). CVD Risk Assessment calculator. <http://www.nzssd.org.nz/cvd/>
- Song, X., Wang, J., Gao, Y., Yu, Y., Zhang, J., Wang, Q., Ma, X., Estille, J., Jin, X., Chen, Y., & Mu, Y. (2019). Critical appraisal and systematic review of guidelines for perioperative diabetes management: 2011-2017. *Endocrine*, 63(2), 204–212. <https://doi.org/10.1007/s12020-018-1786-y>.
- Wang, J., Luo, X., Jin, X., Lv, M., Li, X., Dou, J., Zeng, J., An, P., Chen, Y., Chen, K., & Mu, Y. (2020). Effects of Preoperative HbA1c Levels on the Postoperative Outcomes of Coronary Artery Disease Surgical Treatment in Patients with Diabetes Mellitus and Nondiabetic Patients: A Systematic Review and Meta-Analysis. *Journal of Diabetes Research*, 2020, 3547491. <https://doi.org/10.1155/2020/3547491>.

9. Associated documents

Perioperative documents

- Diabetes – Bariatric Perioperative Management (Anaesthesia Department guideline 2022)
- Diabetes – Ketone Meters for Perioperative Care SOP (Standard Operating Procedure 2022)

Te Toka Tumai Auckland wide documents

- Diabetic Ketoacidosis (DKA) management
- Diabetes in Pregnancy
- Medications - Allergies and adverse drug reactions - Identification, documentation and reporting
- Medications - Prescribing
- RMO Clinical Handbook (also refer to sections on DKA and HHS)
- ADHB - Inpatient Diabetes Management

National guidelines

- New Zealand Child and Youth Clinical Networks. (2020). *Diabetic Ketoacidosis (DKA) management*. <https://starship.org.nz/guidelines/diabetic-ketoacidosis-dka-management/>
- Australian Diabetes Society & New Zealand Society for the Study of Diabetes. (2022). *Alert Update July 2022. Periprocedural Diabetic Ketoacidosis (DKA) with SGLT2 Inhibitor use in people with diabetes*. <https://diabetessociety.com.au/position-statements-guidelines-type-2.asp>

Clinical forms

- CR5660 IV Fluid Prescription
- CR9194 Diabetes Insulin Prescription and Blood Glucose Record

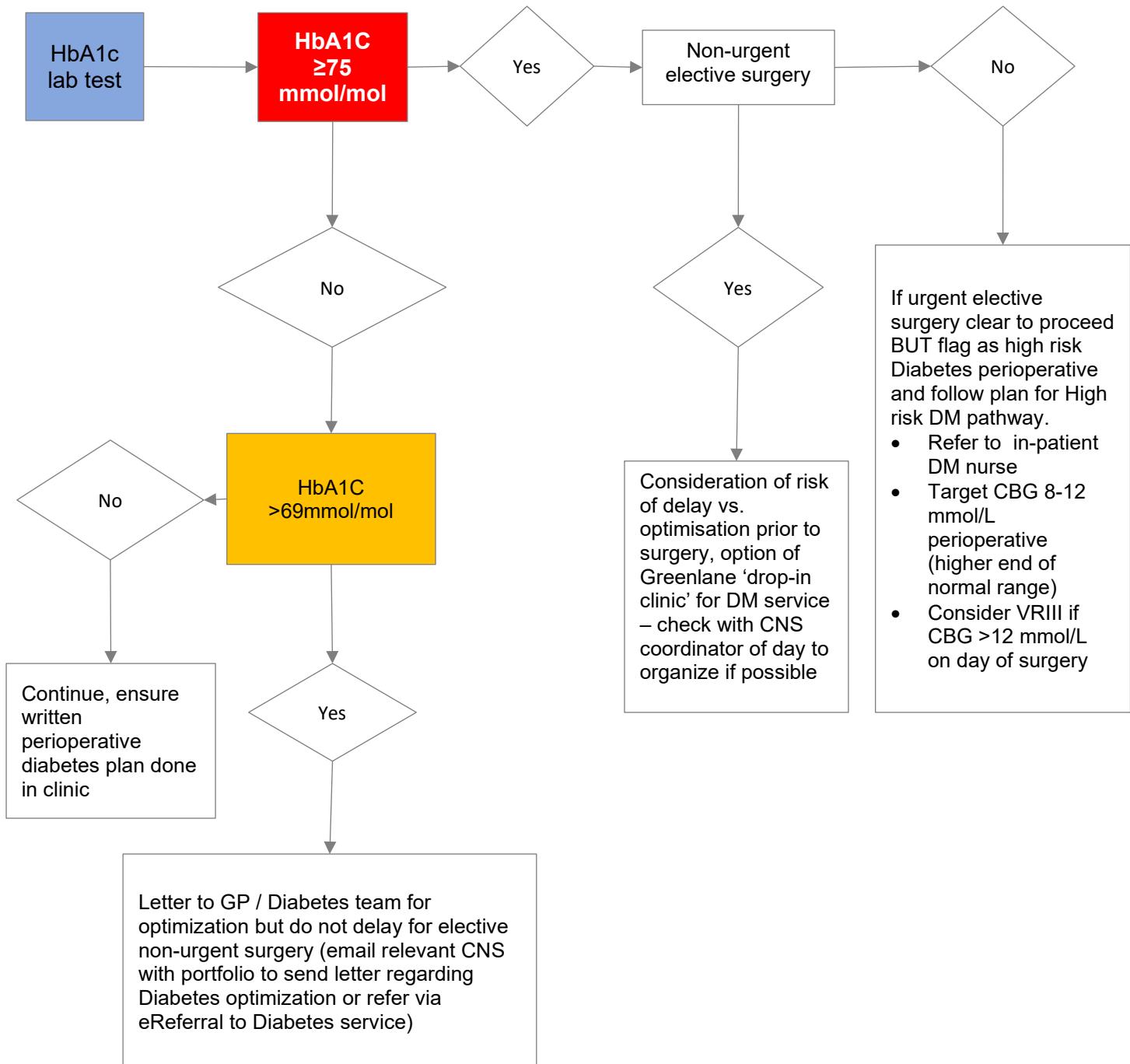
10. Disclaimer

No guideline can cover all variations required for specific circumstances. It is the responsibility of the health care practitioners using this Auckland DHB guideline to adapt it for safe use within their own institution, recognise the need for specialist help, and call for it without delay, when an individual patient falls outside of the boundaries of this guideline.

11. Corrections and amendments

The next scheduled review of this document is as per the document classification table (page 1). However, if the reader notices any errors or believes that the document should be reviewed before the scheduled date, they should contact the owner or [Document Control](#) without delay.

Appendix 1: Elevated HbA1c flowchart



Appendix 2: Diabetes Insulin Prescription and Blood Glucose Record (CR9194)

Example of Insulin Prescription Chart (these are available in the Preassessment Clinic):

Diabetes Management: **Variable Rate Insulin Infusion (VRIII) for hyperglycaemia in DKA** OR **Treatment of Hyperkalaemia ($K+ > 6.5 \text{ mmol/L}$)**

Indicate if IV insulin infusion alone or with additional fluids

Adipriad 10 units + glucose 10% 500 mL IV over 60-120 minutes (fluid-restricted patients: use 100 mL 10% glucose 10%)

If appropriate for the patient, write a separate fluid prescription on the back of the National Medication Chart.

Variable Rate Intravenous Insulin Infusion (VRII): for hyperglycaemia or treatment of hyperkalaemia

Appendix 3: Hyperglycaemia correction doses

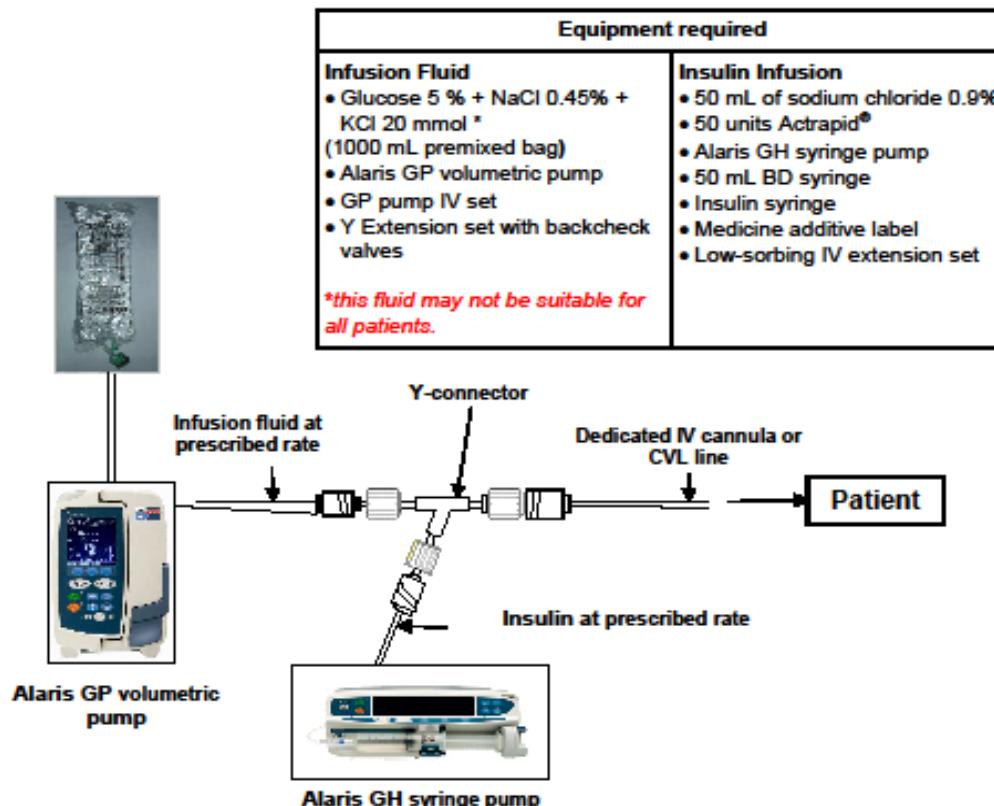
STAT INSULIN DOSES FOR HYPERGLYCAEMIA IN ADULTS

If hyperglycaemic, use rapid-acting insulin (e.g. Novorapid®)
for correction *in addition to* usual insulin

Blood glucose	A Total daily insulin <40 units/day	B Total daily insulin 40-80 units/day	C Total daily insulin >80 units/day
11-13.9 mmol/L	2 units	3 units	4 units
14-16.9 mmol/L	3 units	5 units	7 units
17-19.9 mmol/L	4 units	7 units	10 units
20-22.9 mmol/L	5 units	9 units	13 units
≥23 mmol/L	6 units	11 units	16 units

Appendix 4: Variable rate intravenous insulin infusion - set up

Setting up a Variable Rate Intravenous Insulin Infusion & fluid (Adult)



Step	Action
1	Draw up 50 units of Actrapid® insulin (0.5 mL) in an insulin syringe
2	Draw up 49.5 mL of sodium chloride 0.9% in a 50 mL BD syringe
3	Add the 0.5 mL of insulin to the sodium chloride 0.9% to give a 1 unit/mL solution (total volume = 50 mL) Label the syringe "1 unit/mL insulin in sodium chloride 0.9%"
4	Attach the low-sorbing IV extension set to the syringe. Label the insulin line.
5	Attach the insulin line to the Y-connector. The Y-connector must have backcheck valves
6	Manually prime the insulin line and the arm of the Y-connector and then clamp insulin line. Insert syringe into syringe driver.
7	Program Guardrails (select "Insulin") on syringe pump and select rate of insulin infusion as per prescribed scale (default is Scale B e.g. 3 units/hr)
8	Attach the GP pump IV set to the prescribed fluid bag. Label the infusion fluid line.
9	Attach the infusion fluid line to the Y-connector
10	Prime the infusion fluid line and the arm of Y-connector. Ensure at least 3 mL of solution drains from the Y-connector before connecting to the patient. Clamp fluid line
11	Program Guardrails (select "G/K Fluid") on GP pump and administer the fluid via volumetric pump at prescribed rate e.g. 80 mL/hr
12	Unclamp both lines and start infusions

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Appendix 5: Extra reading on SGLT2i medications

SGLT2 Inhibitor mechanism of action

Glucose is normally freely filtered through the kidney but very little is excreted in urine because it is actively re-absorbed back into the blood by the kidney. There are several transport channels in the kidney which cause this reabsorption of glucose. The SGLT2 is one of them.

SGLT2 inhibitors block that pathway. So they reduce glucose levels and circulating fluid volume by inhibiting their reabsorption and causing more urinary excretion of glucose and sodium.

Indications and advantages

SGLT2 inhibitors are recommended as the second line diabetic agent for patients with cardiovascular disease, especially heart failure and in people with renal disease.

Some of the advantages of SGLT2 inhibitors include:

- A slowing in renal disease progression.
- Reduced mortality from cardiovascular events (especially heart failure)
- Associated weight loss and reduction in blood pressure
- They do not cause hypoglycaemia by themselves
- These benefits are independent of the improved glycaemic control patients get by taking them.

Currently available SGLT2 Inhibitors

- **Empagliflozin** - Available on its own (Jardiance), or as a combination drug with Metformin (Jardiamet).
- **Dapagliflozin** - Available on its own (Forxiga), or as a combination drug with Metformin (Xigduo).
- **Canagliflozin**
- Be cautious of anything ending in 'gliflozin' - some patients get non-funded alternatives.

Important: SGLT2i and Risk of DKA

- SGLT2 inhibitors carry a small but definite risk of severe diabetic ketoacidosis (DKA).
- Sometimes this DKA is associated with near normal or only mildly elevated blood glucose levels i.e. euglycaemic ketoacidosis (EuDKA)
- For more information on EuDKA, please refer to [Section 5.2.5](#) of this document