

# Management of Patients with Diabetes in the Peri-operative Period

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## Section A – General Principles

### 1.0 Key points

- 1.1 Target capillary blood glucose reading (CBG) throughout an admission is **6 to 12mmol/l**.
- 1.2 Low or high CBG readings **MUST** be managed promptly. Information from this guidance can be used as a reference, taking into account patient variation factors. Specialist advice from the Diabetes team should be sought especially for management of complex cases.
- 1.3 Patients should be involved in the peri-operative management of their diabetes. This can be initiated in the Pre-Assessment Clinic. A key aspect to good peri-operative diabetes management is an early and robust management plan in the pre-assessment period.
- 1.4 A HbA1c reading should be obtained within 3 months of the planned surgery to assess glycaemic control. Pre-operative management of patients with HbA1c  $\geq 69$ mmol/mol should be discussed with the Diabetes team or an anaesthetist. Consideration should be given to optimise diabetic control by referring to the patient's GP or the Diabetes team ideally within this time period. Patients with suboptimally controlled diabetes undergoing emergency/urgent procedures (where there is insufficient time to optimise control) should be highlighted to the Diabetes team as soon as possible.
- 1.5 Patients with diabetes should be prioritised for surgery whenever possible (*eg: placed first on the list*).
- 1.6 Not all patients require a variable rate intravenous insulin infusion (VRIII) – previously known as a sliding scale. Patients undergoing a short fast (likely to miss only one meal) can be managed by modifications of their medications. See guidance in 'Section A point 4.0' and 'Section B' for more information.
- 1.7 Diabetic patients who are initiated on artificial feeding (TPN, NG, NJ, RIG feeding etc) should have a management plan discussed with the Diabetes Team when feeding starts.

## **2.0 Capillary blood glucose (CBG) testing**

- 2.1 Test CBG at least four times a day in the peri-operative period for all patients with diabetes (including diet-controlled).
- 2.2 During the fasting period, test CBG every 2 hours.
- 2.3 Record of CBG is also recommended in the following stages:
  - a. Just before start of procedure
  - b. Just after completion of procedure
  - c. At least once when in recovery
  - d. On arrival back to ward
- 2.4 A higher frequency of testing may be required if the patient's blood glucose or CBG is labile.
- 2.5 Test immediately if the patient is displaying signs and symptoms of hypo- or hyperglycaemia and treat accordingly as per local guidance.
- 2.6 Patients on a VRIII should have hourly CBG readings. Reduce to 2 hourly if CBG readings remain stable for 4 hours, with no insulin infusion rate changes.

## **3.0 Patients using continuous subcutaneous insulin infusion (CSII) pumps at home**

- 3.1 Management of patients with CSII pumps should be discussed with the Diabetes team at the earliest opportunity.
- 3.2 CSII pumps should be stopped and disconnected in the following patients:
  - a. Critically unwell
  - b. Undergoing major surgery
  - c. Unable to self-manage CSII pump independently
  - d. Undergoing radiological procedures
  - e. Patients who do not have supply of own consumables eg. infusion sets
- 3.3 If the pump is likely to be disconnected for more than 1 hour, ensure an alternative source of insulin is started - a VRIII is a suitable option unless otherwise advised by the Diabetes team.
- 3.4 Prolonged disconnection of a CSII pump will result in DKA unless alternative insulin is given.
- 3.5 Inpatient guidance on CSII pumps can be found on the 'Edinburgh Centre for Endocrinology and Diabetes' website: <http://www.edinburghdiabetes.com/>

## 4.0 Management of diabetic medications in the fasting period

- 4.1 For emergency cases, it is likely that more than one meal will be missed. Attempt to get an estimate of the time of procedure (morning or afternoon). Start VRIII unless it is certain that only 1 meal will be missed. Please discuss with anaesthetic team performing individual assessments (if applicable).
- 4.2 For bowel surgery, patients may continue to have little to no oral intake. Use of VRIII may be appropriate for 48 hours post-procedure. For cases where this is likely to continue beyond 48 hours, please contact Diabetes team for specialist advice for ongoing management.

INSULINS				
Type	Day before operation	Day of operation		Advice if VRIII is being used
		Morning operation	Afternoon operation	
<b>Long acting insulin</b> (taken in the evening)  <i>eg: Lantus, Levemir, Tresiba, Insulatard, Humulin I</i>	Take as normal*	Restart at usual dose when eating.	Restart at usual dose when eating.	Continue at 80% of usual dose when VRIII is in use. When VRIII is stopped restart 100% of usual dose.
<b>Long acting insulin</b> (taken in the morning)  <i>eg: Lantus, Levemir, Tresiba, Insulatard, Humulin I</i>	Take as normal*	Take as normal*	Take as normal*	Continue at 80% of usual dose when VRIII is in use. When VRIII is stopped restart 100% of usual dose.
<b>*Reduction to 80% of dose of long acting insulin on day before operation should be considered in patients with very tight glycaemic control or patients who report a drop in CBG &gt;2mmol/l overnight. This may include patients on large doses of long acting insulin to account for oral intake.</b>				
<b>Mix insulin</b>  <i>eg: Novomix 30, Humalog Mix 25, Humulin M3</i>	Take as normal	Continue at 50% of usual dose in the morning.  Restart at usual dose when eating.	Continue at 50% of usual dose in the morning.  Restart at usual dose when eating.	Stop when VRIII is in use. Restart when eating and drinking. Dose may vary if oral intake is reduced compared to normal oral intake.  *If > 1 missed meal, stop mix insulin and start VRIII.
<b>For twice daily long acting insulin (eg: Lantus, Levemir, Insulatard, Humulin I) please follow guidance for mix insulin.</b>				
<b>Short acting insulin</b>  <i>eg: Novorapid, Actrapid, Apidra, Humalog</i>	Take as normal	Stop  Restart when eating. Consider adjusting dose if oral intake is reduced.	Take morning dose with breakfast then stop.  Restart when eating. Dose may vary if oral intake is reduced.	Stop when VRIII is in use. Restart when eating and drinking. Dose may vary if oral intake is reduced.  *If > 1 missed meal, stop short acting insulin and start VRIII.

## ORAL AND NON-INSULIN BASED AGENTS

Type	Day before operation	Day of operation		Advice if VRII is being used
		Morning operation	Afternoon operation	
<b>Metformin*</b>	Take as normal	Stop	Stop	Stop when VRIII is in use.  *If >1 missed meal, stop and start VRIII if CBG persistently >14mmol/l.
	<b>*Metformin may be withheld 24 hours before and 48 hours after procedure involving contrast. Consider withholding when concerns with renal injury and infection.</b>			
<b>SGLT-2 inhibitor</b>  <i>eg: empaglifozin, dapaglifozin, canaglifozin</i>	Stop**	Stop	Stop	Stop
	<b>**For patients with poorly controlled diabetes (HbA1c &gt;69mmol/mol) and at risk of dehydration, stop at least 3 days before procedure. Do not restart until patient is eating well and is adequately hydrated. Please contact Diabetes team for advice if alternative blood glucose control required.</b>  <b>SGLT-2 inhibitors MUST be withheld in acute serious illnesses and where emergency surgery is indicated due to the increased likelihood of deterioration of the patient's hydration status. Continued use of SGLT-2 inhibitors in these situations may lead to ketoacidosis, including euglycaemic ketoacidosis.</b>			
<b>GLP-1 analogue</b>  <i>eg: exenatide, liraglutide, dulaglutide</i>	Take as normal	Take as normal.	Take as normal.	Stop
	<b>For patients undergoing bowel surgery, do not restart until patient is eating well. GLP-1 analogues may affect intestinal motility.</b>			
<b>Sulphonylureas</b>  <i>eg: gliclazide, glibenclamide, glimepiride</i>	Take as normal	If taken once a day in the morning, omit dose.	If taken once a day in the morning, omit dose.	Stop when VRIII is in use.  *If >1 missed meal, stop and start VRIII if CBG persistently >14mmol/l.  Do not restart until eating.
		If taken twice a day, omit morning dose.	If taken twice a day, omit both doses.	
<b>Thiazolidinediones</b>  <i>eg: pioglitazone</i>	Take as normal	Take as normal.	Take as normal.	Stop when VRIII is in use.  *If >1 missed meal, stop and start VRIII if BMs persistently >14mmol/l.
		Do not restart until eating.	Do not restart until eating.	
<b>Meglitinide</b>  <i>eg: repaglinide, nateglinide</i>	Take as normal	Stop	Take in the morning if eating.	Stop when VRIII is in use.  *If >1 missed meal, stop and start VRIII if CBG persistently >14mmol/l.  Do not restart until eating.
		Take as normal.	Take as normal.	
<b>DPP-IV inhibitor</b>  <i>eg: sitagliptin, saxagliptin, vildagliptin, alogliptin, linagliptin</i>	Take as normal	Take as normal.	Take as normal.	Stop when VRIII is in use.  *If >1 missed meal, stop and start VRIII if CBG persistently >14mmol/l.
		Take as normal.	Take as normal.	

## 5.0 Post-Operative Care

- 5.1 A carefully documented plan post-procedure is vital.
- 5.2 Restart regular diabetic medication at their normal administration times once the patient is eating.
- 5.3 VRIII should be stopped when the patient is able to maintain good oral intake. Allow an overlap of at least 30 to 60 minutes with regular diabetic medication before stopping VRIII.
- 5.4 Doses of insulin and oral medications may need to be adjusted to compensate for any reduction in carbohydrate intake or stress-induced hypo or hyperglycaemia. If unsure, please discuss with a senior clinician or the Diabetes team for specialist advice.
- 5.5 Restart a patient's CSII pump as soon as the patient starts eating and drinking normally and allow an overlap of at least 1 hour before stopping VRIII. Do not recommence CSII at bedtime.
- 5.6 A VRIII may be appropriate for patients on enteral feeding or total parenteral nutrition (TPN) in the short term, but a SC insulin regimen is preferable. Please discuss with the Diabetes team for specialist advice prior to commencing artificial feeding. Information on the patient's diabetes treatment, CBG readings and total carbohydrate in enteral feed or TPN bags will assist in consultation.

## Section B - Variable rate intravenous insulin infusion (VRIII)

**VRIII use may lead to hypo- or hyperglycaemia and ketosis on cessation. It can also cause hyponatraemia due to large volume of fluid delivery. These risks are exacerbated by prolonged use. Please seek advice from the Diabetes team when the duration extends beyond 48 hours.**

### 1.0 Indications for a VRIII

1.1 The following groups of patients require a VRIII:

- a. Fasting patients with Type 1 Diabetes missing more than one meal or if background insulin has not been given
- b. Fasting patients with insulin dependent Type 2 Diabetes missing more than one meal
- c. Fasting patients with Type 2 Diabetes with CBG consistently above 14mmol/l
- d. Patients on CSII with the pump disconnected prior to surgery
- e. Patients on the emergency list who are likely to miss >1 meal
- f. Patients who have little to no oral intake post-procedure due to gut rest or post-operative complications (eg: post-operative ileus)

1.2 VRIII may be initiated on the ward or in theatre pre-procedure.

### 2.0 Prescription

2.1 A total of 50units of Actrapid (0.5ml of 100units/ml) should be added to 49.5ml of sodium chloride 0.9% to make a final concentration of 1unit/ml.

2.2 Administer insulin via an infusion pump into the same cannula as the substrate fluid through a non-return valve.

2.3 Long acting insulin (eg: Levemir, Lantus, Tresiba) should be continued at 80% of normal dose with VRIII.

### 3.0 Substrate fluid with VRIII

- 3.1 When making a prescription of substrate fluid, please indicate clearly that this fluid is for VRIII on fluid chart.
- 3.2 The substrate fluid of choice for most patients is glucose 4% and sodium chloride 0.18% with potassium chloride 40mmol in 1000ml.
- 3.3 In Neurosurgery, the substrate fluid of choice is glucose 5% and sodium chloride 0.45% with potassium chloride 20mmol in 500ml.
- 3.4 If potassium level is greater than 5.0mmol/L omit potassium in the substrate fluid.
- 3.5 Addition of potassium in substrate fluid is not required for patients with end stage renal disease or patients on renal replacement therapy. Discuss with senior medical staff or Diabetes team if uncertain.
- 3.6 Monitor serum electrolytes at least once daily to guide the need for additional electrolyte replacement.
- 3.7 The rate of the infusion is determined by the patient's weight as described on the IV fluid chart. The patient's fluid status and clinical condition should also be considered.
- 3.8 For patients with hyponatraemia (sodium <131mmol/l), an increase in sodium content of the infusion substrate fluid will be required at a combined rate suitable for the patient's requirements. Please consult anaesthetist or senior medical staff for advice.

### 4.0 Management of VRIII

- 4.1 Monitor CBG hourly, reducing to 2 hourly if CBG is consistently within 6 to 12mmol/l, with no insulin infusion rate changes.
- 4.2 Rate of infusion should be initiated as per prescription chart, using the most appropriate scale as described on the chart.
- 4.3 Patients with Type 2 diabetes frequently require more insulin. For persistent hyperglycaemia (three consecutive CBG readings >12mmol/l without a 3mmol/l/hr drop), increase the maximum VRIII rate by 1unit/hr (eg: switch from scale 2 to scale 3 on the VRIII prescription chart). Several rate increments may be required.
- 4.4 Insulin should not be infused without a substrate fluid (i.e. IV fluid containing glucose) outwith Critical Care areas. This could lead to **severe hypoglycaemia**.

## 5.0 VRIII for patients at risk of fluid overload

- 5.1 Please discuss ongoing use of VRIII in patients with fluid overload with a senior member of staff or seek specialist advice from Diabetes team. Running VRIII for prolonged periods may lead to fluid overload or hyponatraemia. A daily check of urea and electrolytes is mandatory to avoid electrolyte imbalance.
- 5.2 The rate of the substrate fluid typically lies between 50 to 100ml/hr. Depending on the patient's CBG, the rate can be reduced if fluid overload is a concern but caution must be exercised to avoid hypoglycaemia.
- 5.3 Consider using glucose 10% with potassium chloride 10mmol as a substrate fluid for patients at risk of fluid overload (eg: patients with heart failure or renal disease) to limit the amount of substrate fluid required to maintain target CBG.
- 5.4 If potassium level is greater than 5.0mmol/l omit potassium in the substrate fluid.

## 6.0 Stopping the VRIII

- 6.1 The VRIII should be discontinued once the patient is ready to eat and drink at a mealtime without significant nausea or vomiting.
- 6.2 Commence the patient's normal diabetes medication(s) with a meal. This includes oral and SC insulin. The dose of SC insulin may need to be adjusted to compensate for reduced carbohydrate intake. If unsure, please discuss a suitable dose with the patient or the Diabetes team.
- 6.3 An overlapping period of 30 to 60 minutes is required after the patient's regular insulin has been administered before the VRIII is stopped as the half-life of IV insulin is extremely short.
- 6.4 For patients with Type 1 diabetes, ensure the patient's basal insulin has been administered prior to discontinuation of VRIII.
- 6.5 Hypo- or hyperglycaemia is possible after discontinuation of a VRIII. The patient's CBG should be checked regularly and treatment initiated as per recommended guidance in Section C. Seek specialist advice from the Diabetes team if required.



# Section C – Management of Hypo or Hyperglycaemic Episode

## 1.0 Hypoglycaemia

For management of hypoglycaemia (CBG <4mmol/l) please follow Lothian guidance on management of hypoglycaemia. Guidance can be found on the 'Edinburgh Centre for Endocrinology and Diabetes' website: <http://www.edinburghdiabetes.com/>

## 2.0 Hyperglycaemia

For management of hyperglycaemia (persistent CBG above recommended target range) please seek specialist advice from Diabetes team.

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### References:

1. Management of adults with diabetes undergoing surgery and elective procedures: Improving standards (revised march 2016), Joint British Diabetes Societies (JBDS) for inpatient care.

### Peri-operative diabetes management interest group:

- *Jin Hah, Lead Pharmacist Surgery WGH*
- *Dr Stuart Ritchie, Consultant Endocrinologist and Diabetologist WGH*
- *Dr Scott MacKenzie, Consultant Endocrinologist and Diabetologist RIE*
- *Dr Radzi Noh, Consultant Physician SJH*
- *Katharine Ramage, Diabetes Specialist Nurse WGH*
- *Dr Simon Heaney, Consultant Anaesthetist RIE*
- *Dr Morag Renton, Consultant Anaesthetist SJH*
- *Dr Susan Rae, Consultant Anaesthetist WGH*
- *Dr Debbie Morley, Consultant Anaesthetist WGH*
- *Dr Keith Kelly, Consultant Anaesthetist DCN RIE*
- *Nicole Cromar, Lead Pharmacist DCN RIE*

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VRIII is a continuous infusion and is made up of :  
50units (0.5ml) soluble insulin (Actrapid) in  
49.5ml sodium chloride 0.9% (1ml = 1unit Actrapid)

Medicine	Total Dose	Infusion Fluid	Final Concentration	Route	Prescribed by (sign & print)
Actrapid	50units	Sodium Chloride 0.9%	50units in 50ml	IV	

**Prescribe one of the insulin infusion scales below:**

- **Scale 1** should be considered for insulin-sensitive patients, those on less than 24units of insulin per day (eg: elderly or low BMI patients with type 1 diabetes).
- **Scale 2** is suitable for **most patients**.
- **Scale 3** will better suit insulin resistant patients, typically high BMI patients with type 2 diabetes who take a total of over 100 units of insulin per day.
- Do not stop long-acting insulins (eg: Levemir, Lantus, Tresiba) when starting VRIII. Continue at 80% of usual dose. Remember to review the dose again once VRIII has stopped.

Capillary blood glucose (mmol/l)	Scale 1 <i>For Insulin sensitive patients</i>	Scale 2 <i>Standard Rate for most patients</i>	Scale 3 <i>For insulin resistant patients</i>	Scale 4 <i>Custom scale</i>
	Rate (Units/hr)	Rate (Units/hr)	Rate (Units/hr)	Rate (Units/hr)
Less than 4.1	Nil (Treat Hypo)	Nil (Treat Hypo)	Nil (Treat Hypo)	
4.1 - 8.0	0.5	1	2	
8.1 - 12.0	1	2	4	
12.1 - 16.0	2	4	6	
16.1 - 20.0	3	5	7	
20.1 - 24.0	4	6	8	
More than	6	8	10	
Prescriber:				

**Prescriber to sign and print name under the selected scale. Score through scales which are not to be used.**

- Prescribe 1000ml glucose 4% and sodium chloride 0.18% with potassium chloride 40mmol as substrate fluid except in Neurosurgery where 500ml glucose 5% and sodium chloride 0.45% with potassium chloride 20mmol should be used instead. Indicate clearly on fluid chart that this fluid prescription is for VRIII.
- The rate of the infusion is determined by the patient's weight and should match their daily fluid requirement.
- Measure serum electrolytes at least once daily to guide sodium and potassium replacement. If potassium level is greater than 5.0mmol/l, omit potassium in the substrate fluid.
- Administer the insulin via an infusion pump into the same IV cannula as the substrate fluid, through a non-return valve.

