Variable rate intravenous insulin infusion (VRIII) guideline (adults ≥ 16 years of age)

This guidance replaces previous guidance relating to 'insulin sliding scales'.

Principles of VRIII are:

- Desired glucose control is achieved and maintained
- Avoidance of hypoglycaemia
- Avoidance of ketosis by providing adequate carbohydrate and insulin
- Maintenance of fluid and electrolyte balance

Patient group:

DO use the guideline for the following:

- Medical patients with diabetes who have uncontrolled hyperglycaemia or who are unable to eat and drink due to prolonged fasting, nausea, vomiting or reduced consciousness
- Can be used in surgical patients with diabetes undergoing operations e.g. fasting > 24 hours, emergency surgery or poor glycaemic control.

DO NOT use the guideline for the following patient groups (see separate guidelines and seek urgent specialist advice):

- Maintenance of fluid and electrolyte balance
- Diabetic Ketoacidosis (DKA) – refer to DKA care pathway 1 and 2 for management details
- Hyperglycaemic Hyperosmolar State (HHS) / Hyperosmolar Non-Ketotic Coma (HONC) – refer to the Joint British Diabetes Societies guidelines on the management of the hyperosmolar hyperglycaemic state in adults with diabetes for management details.
- Pregnant patients requiring intravenous insulin – refer to Management of pregnant women with diabetes (Type 1, 2 and gestational diabetes) admitted to Ayrshire Maternity. This guideline is for women who are not in labour and who do not require glucocorticoids for promotion of fetal lung maturity – separate guidelines available for these indications.

Before starting VRIII:

- Check bedside capillary blood glucose (CBG) to determine initial insulin rate. See *Table 1*.
- Specify the lower limit target glucose level (usually 4mmol/l is acceptable, but a higher level may be more appropriate in some patients).
- Check U&Es to guide potassium administration for VRIII fluids. See *Table 2*.
- Check if the patient is already on a long-acting insulin (e.g. Humulin I®, Insulatard®, Lantus® Levemir® Abasaglar® or Tresiba® - see BNF for full list). If so, administer at the usual time whilst using VRIII (unless advised otherwise). Seek urgent specialist advice for patients on continuous basal insulin pumps. Pre-mixed insulin (e.g. Humulin M3®, Novomix 30®, HumalogMix 25®, HumalogMix 50®) **should not** be administered whilst on VRIII.

Prescribing & monitoring VRIII:

- Prescribe VRIII on standardised VRIII Prescription, Administration and Monitoring chart (ADTC/MG/03(b)A27/02) and on the inpatient prescribing chart (e.g. inpatient prescription sheet or electronic prescribing) in conjunction with this guideline.
- Nursing staff will adjust insulin infusion rate, according the patient's capillary blood glucose (CBG)
- If issues with the default VRIII guidance (e.g. persistent hypo- or hyperglycaemia), seek advice from the Diabetes Medical Team
- Check CBG hourly (minimum of 2 hourly in a stable patient), more frequent if CBG <4mmol/L (see below)
- If CBG <4mmol/L – stop VRIII and follow the hypoglycaemia treatment guidelines. Check the CBG every 15-30 minutes, as appropriate. When blood glucose levels are stable, check CBG every hour
- If blood glucose >20mmol/L it is important to assess the following:
  - Check pump devices, IV lines and IV cannulae to ensure patients are getting the prescribed insulin dose
  - Consider other causes that could be contributing: sepsis, steroid therapy, obesity
  - Seek senior medical advice with a view to revising insulin rates
- Stopping VRIII in patients who are normally on SC insulin: ensure SC insulin (either long-acting insulin or premixed insulin) has been restarted before stopping VRIII. For advice on this, contact the Diabetes Medical Team.

***Table 1**:* VRIII (initial guide)

Capillary Blood glucose (mmol/L)	Insulin Infusion Rate (units/hour)
<4 (refer to hypoglycaemia treatment guidelines)	0
4 - 7	1
7.1 – 9	2
9.1 – 11	3
11.1 – 14	4
14.1 – 17	5 (check ketones if Type 1)
17.1 - 20	6 (check ketones if Type 1)
>20	Seek senior medical advice # (check ketones)

See prescribing & monitoring of VRIII

Prescribing IV fluids with VRIII

- The fluid regimen used with this VRIII is NOT appropriate for fluid resuscitation.
- **Glucose**-containing fluids **should always be used**: only exceptions are patients in ITU/HDU/CCU areas
- If the patient is receiving **other** IV fluids, continue to prescribe these on a separate fluid chart but (due to the concurrent VRIII fluids) review their flow rate to ensure that the target fluid intake for the patient is not exceeded. Inform nursing staff that there is another fluid chart in use.
- The standard regimen is 0.18% sodium chloride + 4% glucose + 0.15% potassium chloride (pre-prepared infusion bags), run at 100ml/hr. See *Table 2* below for guidance on potassium supplementation.
- A different VRIII IV fluid may be appropriate in certain patient groups (cardiac dysfunction, renal/liver failure, head injury). Seek advice from relevant specialty.
- For patients at risk of fluid overload it may be appropriate to reduce fluid rate to 83ml/hr or consider use of 10% glucose as a substrate at 42ml/hr to reduce volume further if required.

Potassium supplementation (target 4-5mmol/L)

- Vary the potassium chloride content of the VRIII IV fluids according to plasma potassium levels but continue to monitor potassium and re-check U&Es in 4 hours:

Table 2: Guidance on potassium supplementation

Plasma potassium	Prescribe a VRIII IV fluid bag with:	Examples* pre-prepared infusion bags:
< 3.5mmol/L	40mmol potassium chloride/1000mL	0.18% sodium chloride + 4% glucose + 0.3% potassium chloride
3.5 – 5mmol/L	20mmol potassium chloride/1000mL	0.18% sodium chloride + 4% glucose + 0.15% potassium chloride
> 5mmol/L or patient is oligoanuric	Zero potassium	0.18% sodium chloride + 4% glucose

*0.9 % sodium chloride + 5% glucose, with varying amounts of potassium, may be required in some patients (neurosurgery/head trauma/spinal trauma)

- Be prepared to vary the potassium chloride content of IV fluids according to plasma potassium levels which should be monitored at least twice daily
- In patients with renal failure, chronic kidney disease or oliguria seek advice from a member of the Renal or Diabetes Medical Team or senior medical staff on potassium replacement as the regimen above may contain too much potassium

Prescriber review

Review the following at least twice daily (may need to be more frequent depending on the clinical scenario):

- VRIII and blood glucose response – may need to revise insulin infusion rates if persistent hypo- or hyperglycaemia
- Rate of VRIII infusion and type of fluid used
- Potassium level and potassium supplementation

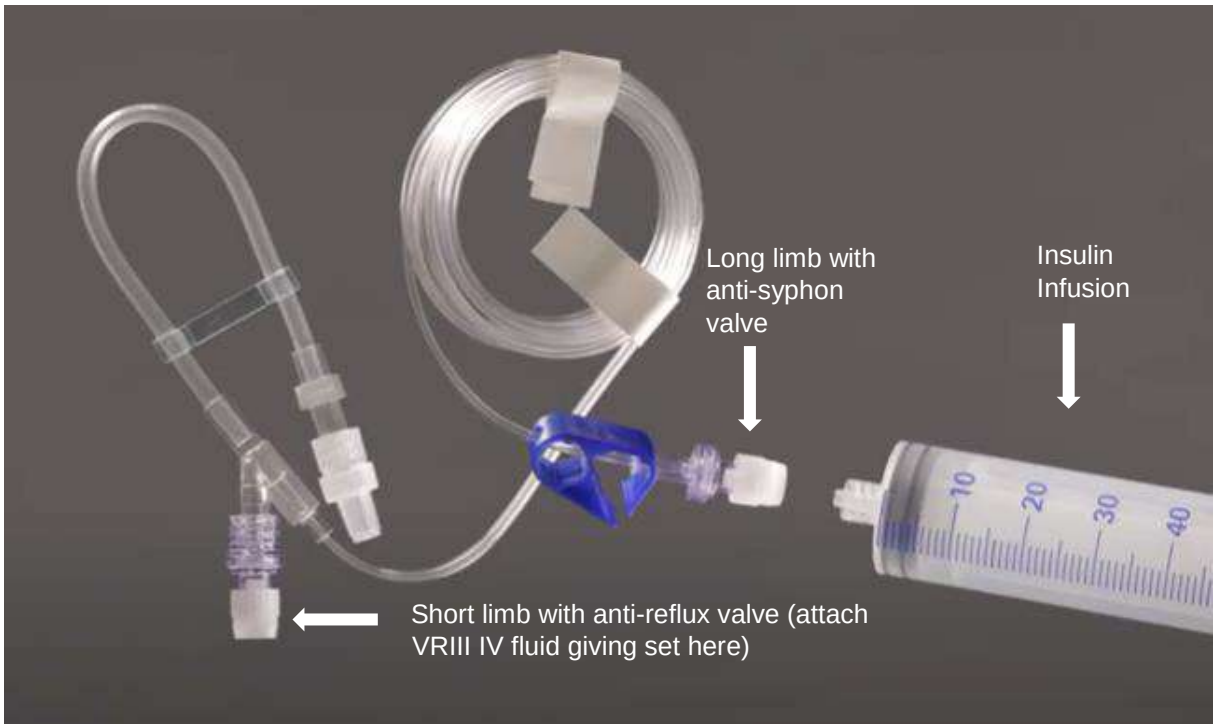
If you are unsure how to review or how to adjust any of these parameters please contact a member of the Diabetes Medical Team. ***Stopping VRIII in patients who are normally on SC insulin: ensure SC insulin (either long-acting or premixed insulin) has been restarted before stopping VRIII.***

Preparation & administration:

- Syringes must be changed every 24 hours and be prescribed by a doctor/independent prescriber.
- Using an insulin syringe, draw up 50 units of soluble insulin (Actrapid®) and add to 49.5ml of 0.9% sodium chloride in a 50ml luer-lock syringe. Prepared concentration is 1 unit/ml.
- Secure a standard giving set to the IV fluid bag.
- Infuse insulin with VRIII IV fluids through the same cannula, using an administration set with anti-syphon and anti-reflux valves e.g. Vygon Protect-a-line 2.
- Attach 50 ml syringe to the long limb of the administration set and attach the giving set from the VRIII IV fluid bag to the port on the short limb (*Figure 1*).
- VRIII IV fluids must be delivered via a volumetric pump.
- Check CBG hourly or as directed by prescriber (minimum of 2 hourly if the patient is stable).
- Check each CBG against the insulin infusion rate prescribed on page 1 of the VRIII prescription chart – adjust the rate of the insulin infusion accordingly.

DO NOT USE Octopus administration set, as it does not contain an anti-syphon valve it is NOT recommended for use with VRIII. **Protect-a-line 2** has both an anti-syphon and an anti-reflux valve and is therefore the recommended administration set.

Figure 1:



Adapted from NHS Greater Glasgow & Clyde Insulin VRIII guideline. Available from: http://handbook.ggcmedicines.org.uk/guidelines/endocrine-system/insulin-sliding-scale/ (accessed 28th November 2022)