NHS
Greater Glasgow and Clyde

CLINICAL GUIDELINE

Diabetes, Variable Rate Intravenous Insulin Infusion

A guideline is intended to assist healthcare professionals in the choice of disease-specific treatments.

Clinical judgement should be exercised on the applicability of any guideline, influenced by individual patient characteristics. Clinicians should be mindful of the potential for harmful polypharmacy and increased susceptibility to adverse drug reactions in patients with multiple morbidities or frailty.

If, after discussion with the patient or carer, there are good reasons for not following a guideline, it is good practice to record these and communicate them to others involved in the care of the patient.

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Does this version include changes to clinical advice:	No
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Important Note:

The Intranet version of this document is the only version that is maintained.
Any printed copies should therefore be viewed as 'Uncontrolled' and as such, may not necessarily contain the latest updates and amendments.

Variable rate intravenous insulin infusion (VRIII)

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:

- Surgical patients with diabetes undergoing operations e.g. fasting > 24 hrs, emergency surgery and poor glycaemic control
- 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

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

- Diabetic Ketoacidosis (DKA)
- Hyperglycaemic Hyperosmolar State (HHS) / Hyperosmolar Non-Ketotic Coma (HONC)
- Pregnant patients requiring intravenous insulin

Before starting VRIII:

- Check bedside capillary blood glucose (CBG) to determine initial insulin rate. See Table 2 on p. 5
- Specify the lower limit target glucose level (usually 4mmol/l is acceptable in an awake patient, but it may be preferable to aim for a lower limit of 6mmol/l in an anaesthetised patient)
- Check U&Es to guide potassium administration for VRIII fluids. See Table 1 on p. 4
- 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 VRIII:

- Refer to Table 2 on p.5
- Use the standardised VRIII Prescription, Administration and Monitoring chart (PECOS number GGC0259 - click here to view the chart) 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 senior medical staff with a view to revising the insulin rates
- 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 (or reduce to 0.5 units of insulin per hour if no long-acting insulin on board) and follow the guidelines for Acute Hypoglycaemia. 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 your local Diabetes Team (via TrakCare).

Prescribing IV fluids with VRIII

- The fluid regimen used with this VRIII is **not** appropriate for fluid resuscitation (see IV fluids – special patient groups)
- **Glucose-**containing fluids **should always** be used: only exceptions are patients in ITU/HDU/CCU areas
- Use the standardised VRIII Prescription, Administration and Monitoring chart (PECOS number GGC0259 - click here to view the chart) in conjunction with this guideline
- The standard regimen is **0.45% sodium chloride + 5% glucose + 0.15% potassium chloride** (pre-prepared infusion bags) run at 100ml/hr - run 5 x 500ml bags consecutively i.e. 5 bags (2500ml) over 25 hours
- If the above fluid is unavailable, use **0.18% sodium chloride + 4% glucose + 0.15% potassium chloride** (pre-prepared infusion bags) as an alternative, run at 100ml/hr - run 5 x 500ml bags consecutively i.e. 5 bags (2500ml) over 25 hours
- Refer to the GGC Adult Therapeutics Handbook for designated stock locations of VRIII fluids.
- If the patient is receiving **other** IV fluids (e.g. for daily maintenance), 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.
- See Table 1 (page 4) for guidance on potassium supplementation
- See below for prescribing in special patient groups.

IV fluids – special patient groups:

- A different VRIII IV fluid may be appropriate in certain patient groups. Seek advice from relevant specialty
- Neurosurgery/head trauma/spinal trauma: risk of brain and spinal cord oedema, therefore, **0.9 %** sodium chloride + 5 % glucose + 0.15 % potassium chloride (at **80 mls/hour**) may be indicated (see Table 1 (page 4) below for guidance on potassium supplementation).
- Renal impairment/heart failure: Care should be taken when administering large volumes of IV crystalloid to patients vulnerable to salt and fluid overload. This includes patients with heart failure, oliguric AKI and CKD 3b, 4 and 5 who are euvolaemic after appropriate fluid resuscitation. Most importantly these patients need regular review of their fluid status and appropriate change in the rate of IV fluid administration if there are signs of fluid overload.
- Fluid resuscitation or intra-operative losses: additional IV fluids will be required (a separate non-glucose-containing infusion fluid and infusion line should be used)

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 1: Guidance on potassium supplementation

Plasma potassium	Prescribe a VRIII IV fluid bag with:	Examples* of **500ml** pre-prepared infusion bags: (See Adult Therapeutics Handbook for full list of VRIII IV fluid bags and designated stock locations)
< 3.5mmol/L	20mmol potassium chloride	0.45% sodium chloride + 5% glucose + 0.3% potassium chloride **OR** 0.18% sodium chloride + 4% glucose + 0.3% potassium chloride
3.5 – 5mmol/L	10mmol potassium chloride	0.45% sodium chloride + 5% glucose + 0.15% potassium chloride **OR** 0.18% sodium chloride + 4% glucose + 0.15% potassium chloride
> 5mmol/L or patient is anuric	Zero potassium	0.45% sodium chloride + 5% glucose **OR** 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)

- If renal impairment (i.e. CKD, AKI) or oliguria: seek senior advice or contact Renal or Diabetes Team

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 IV fluid infusion and type of fluid used
- Potassium level and potassium supplementation

Preparation & administration (Nursing staff):

- Syringes must be changed every 24 hours and be prescribed by a doctor.
- Using an **insulin syringe**, draw up 50 units of soluble insulin (Actrapid® or Humulin S®) 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 (Fig. 1) and attach the giving set from the VRIII IV fluid bag to the port on the *short* limb (Fig. 2).
- 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.

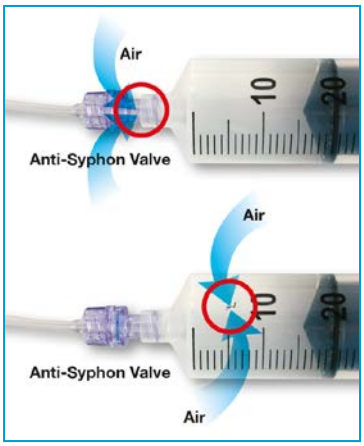

Figure 1

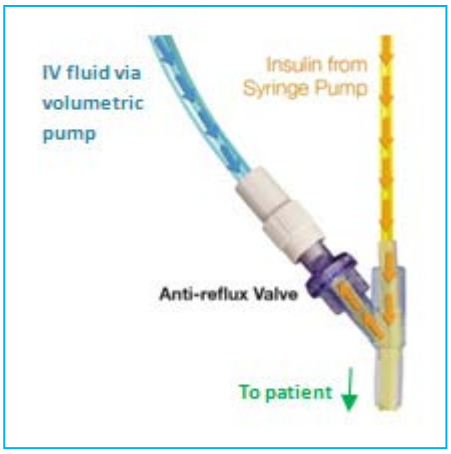

Figure 2

Table 2 – VRIII (initial guide)

Capillary blood glucose (mmol/L)	Insulin Infusion Rate (units/hour)
<4 **(treat as per Acute Hypoglycaemia guideline)**	**0** (if long-acting insulin has been given) **0.5** (if long-acting insulin has not been given)
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)