Worcestershire Acute Hospitals NHS Trust

Guideline for the Use of Continuous Variable Rate Intravenous Insulin Infusion (CVRIII)

This guidance does not override the individual responsibility of health professionals to make appropriate decisions according to the circumstances of the individual patient in consultation with the patient and /or carer. Health care professionals must be prepared to justify any deviation from this guidance.

Introduction

This guideline should be used for the management of patients who are admitted to hospital and require a continuous variable rate intravenous insulin infusion (CVRIII). Evidence suggests that a protocol should be used which optimises glycaemic control but prevents hypoglycaemia occurring.

This guideline is for use by the following staff groups :

All qualified health care professionals involved with caring for in-patients with diabetes in secondary care. Training for all qualified nurses and medical staff will be provided by the local Diabetes Team.

Lead Clinician(S)

Dr David Jenkins	Consultant Diabetologist, Diabetes and Metabolism Centre WRH
Susan Rogers	Diabetes Specialist Nurse, Diabetes and Metabolism Centre WRH

Approved by Accountable Director on:	13th October 2015
Extension Approved on:	9th February 2023
Review Date: This is the most current document and is to be used until a revised version is available	31st May 2023

Key amendments to this guideline

Date	Amendment	By:
15/12/10	Approved by Medicines safety committee	
07/02/11	Point 6 – addition of 'or if setting up peri-operatively', use a 2 or 3 tailed device with non-return valves	Rachael Leese
18/08/12	Blood glucose targets changed 7 – 11mmols	Susan Rogers
18/08/12	Once usual diabetes management is initiated, initially monitor CBG 2 hourly, until 4 consecutive blood glucose readings are between 7 – 11 mmols. Changed the name of guideline to the use of variable rate intravenous insulin infusion.	Susan Rogers
05/12/12	Amended to read: Patients with Type 1 or 2 Diabetes in Pregnancy and patients with Gestational Diabetes. Please refer to WAHT-OBS-038 and WAHT-OBS-039 in the first instance.	Rachel Duckett
06/06/13	Minor amendments made – These include the deletion of the term 'sliding' throughout the document.	David Jenkins
06/06/13	Minor amendments made – These include removal of the terminology DIGAMI, updated the term scale to variable rate (as will appear on the new prescription) and updated CVRIII abbreviation.	Rachael Leese
24/08/13	Updated to reflect the guidance given in the new CVRIII chart – This includes the new variable rate regimens, guidance on CBG monitoring and guidance on prescribing the components of CVRIII.	Rachael Leese
24/10/13	Inclusion of summary flow chart for prescribing CVRIII	Rachael Leese
08/10/2015	No changes to document	Dr Ferring
November 2017	Document extended whilst under review	TLG
December 2017	Sentence added in at the request of the Coroner	
December 2017	Document extended for 3 months as per TLG recommendation	TLG
March 2018	Document extended for 3 months as approved by TLG	TLG
June 2018	Document extended for 3 months as per TLG recommendation	TLG
June 2019	Document extended for 6 months during review and approval process	Alison Hall
February 2021	Document extended as per Trust agreement 11.02.2021.	
April 2022	Document extended until 31st May whilst under review	Sue Smith DDN
February 2023	Document extended for 3 months while the new version is being reviewed and approved.	Alison Hall

Guideline for the Use of Continuous Variable Rate Intravenous Insulin Infusion (CVRIII)

Introduction

The administration of continuous variable rate intravenous insulin infusion (CVRIII) is an essential element of the appropriate management for a wide range of clinical conditions in a diabetic patient. Failure to prescribe and administer intravenous insulin infusion and accompanying intravenous fluids appropriately can result in serious harm to the patient. The safe prescribing and administration of CVRIII with appropriate monitoring is an integral part of the Healthcare Professional's role.

Inclusion Criteria

This guideline on CVRIII should be used for the following adult diabetic patients who are admitted to hospital with:

- Type 1 Diabetes Mellitus and vomiting/ intercurrent illness/ unable to eat or drink.
- Type 1 or Type 2 Diabetes Mellitus and are 'nil by mouth' awaiting surgery or a procedure where CVRIII is indicated. Please refer to WAHT-END-0005.
- Type 1 or Type 2 Diabetes Mellitus within 24 hours post acute stroke with capillary blood glucose (CBG) above 11.0mmol/l.
- Type 1 or Type 2 Diabetes Mellitus with CBG above 11.0mmol/l complicating acute renal, cardiac or liver failure.

This guideline on CVRIII should also be used for the following diabetic patients who are admitted to hospital as outlined below. However, the specific recommendations for accompanying and rehydration/resuscitation intravenous fluids must be followed in the relevant referenced guideline.

- Hyperosmolar Hyperglycaemic State (HHS: formerly known as Hyperosmolar Non-Ketotic Coma). Please refer to WAHT-END-008 for further guidance and recommendations regarding rehydration/resuscitation intravenous fluids.
- Acute coronary syndromes (ACS: myocardial infarction and unstable angina) use Hyperglycaemia in ACS Guidance. Please refer to WAHT-END-002 for further guidance and recommendations regarding accompanying intravenous fluids.

For Patients with Type 1 or 2 Diabetes Mellitus in Pregnancy and patients with Gestational Diabetes. Please refer to WAHT-OBS-038 and WAHT-OBS-039 for further guidance in the first instance.

The reason for commencing CVRIII must be documented in the medical notes and page 1 of the trust approved CVRIII prescription (WR2170).

Exclusion Criteria

This guideline on CVRIII should NOT be used for the clinical circumstances outlined below. The specific CVRIII protocol or fixed rate intravenous insulin infusion must be followed in the relevant referenced guideline.

- Patients admitted with Diabetic Ketoacidosis (DKA). Please refer to WAHT-END-001 for further guidance in the first instance.
- Paediatric patients.

Details Of The Guideline

1. All patients presenting with the conditions outlined above should be commenced on CVRIII.
   a. Subcutaneous insulin injections of short/rapid acting insulin or biphasic insulin **(ref: appendix 1)**, subcutaneous GLP-1 analogue injections e.g. exenatide and oral hypoglycaemic agents (OHA's) e.g. metformin must be stopped.
   b. Subcutaneous injections of intermediate or long acting (basal) insulin **(ref: appendix 1)** may be continued concurrently with CVRIII in the following clinical circumstances: patients with Type 1 Diabetes Mellitus, DKA, HHS, diabetes in pregnancy receiving steroids for foetal lung maturation and ACS. In all other clinical circumstances it should be stopped, unless specified by a member of the Diabetes Team in the medical notes. Continued basal insulin must be prescribed on the trust approved subcutaneous insulin prescription (WR2169).

2. CVRIII comprises: intravenous insulin infusion and accompanying intravenous fluids. Intravenous insulin infusion and accompanying intravenous fluids must be prescribed on the trust approved CVRIII prescription (WR2170).

3. Baseline CBG must be tested and recorded on the relevant section of page 2 and 4 of the CVRIII prescription (WR2170), prior to commencing CVRIII.

4. Intravenous insulin infusion is prescribed once only on page 2 of the CVRIII prescription (WR2170). It is prepared as follows:

   Insulin Actrapid 50 units must be measured using an insulin syringe and made up to 50mls with 0.9% sodium chloride. This should be administered via a syringe pump. The patient should be commenced on the correct point of variable rate regimen 1 according to their baseline CBG **(ref: appendix 2)**. Each syringe preparation and rate change must be documented by two members of nursing staff on the relevant section of the CVRIII prescription (WR2170).

5. Accompanying intravenous fluids are prescribed on page 3 of the CVRIII prescription (WR2170) and prepared as follows:

   a. **Medical and obstetric patients**
      The following accompanying intravenous fluids should be prescribed:
      - if CBG is 13.9 mmol/l or below commence 5% glucose
      - if CBG is 14.0 mmol/l or above commence 0.9% sodium chloride

      Alternate between these infusion fluids (they must not be used concurrently) according to the CBG reading e.g. if 13.9mmol/l use 5% glucose, if 14.0mmol/l use 0.9% sodium chloride at the rate set out below.

      Patients should be assessed individually for level of hydration and appropriate additional rehydration/resuscitation fluid prescribed on the trust approved prescription for intravenous fluids (WR0992). Additional fluids must be administered via a separate intravenous cannula to those intravenous fluids accompanying CVRIII. Accompanying intravenous fluid should be prescribed and administered at the following suggested rates:
      - 15mls per hour for patients with heart failure
      - 30mls per hour for patients without heart failure

      In addition to considering the need for additional rehydration/resuscitation fluids; an assessment should be made for the addition of potassium chloride to accompanying intravenous fluids as deemed clinically appropriate.

Please note that the maximum concentration to be given peripherally is 40mmol potassium/litre and the maximum rate is 10mmol potassium/hour. A commercially available infusion fluid containing potassium should always be used where possible. Please refer to MedPolSOP23 (Trust Medicines Policy) for the management of situations requiring a product which is not commercially available.

Please note accompanying intravenous fluids should only be prescribed if clinically indicated in ACS (refer to WAHT-END-002). Please follow the specific guidance outlined in WAHT-END-008 for rehydration/resuscitation fluids in HHS.

b. Surgical patients

The following accompanying intravenous fluid should be prescribed:

- sodium chloride 0.45% with glucose 5% regardless of CBG

Accompanying intravenous fluid should be prescribed in mls/hour at a rate to deliver the hourly fluid requirements of the patient i.e. a rate which prevents the patient becoming hypoglycaemic and rehydrates/resuscitates the patient.

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An assessment should be made for the addition of potassium chloride to accompanying intravenous fluids as deemed clinically appropriate.

Please note that the maximum concentration to be given peripherally is 40mmol potassium/litre and the maximum rate is 10mmol potassium/hour. A commercially available infusion fluid containing potassium should always be used where possible. Please refer to MedPolSOP23 (Trust Medicines Policy) for the management of situations requiring a product which is not commercially available.

6. The insulin syringe pump should be connected to an intravenous access separate from the accompanying intravenous fluids. However, if venous access is difficult or if setting up peri-operatively, use a 2 or 3 tailed device with **non-return valves.** Packaging of equipment should be checked carefully to ensure the chosen device does have non-return valves.

7. Commence the insulin infusion rate on the appropriate point of variable rate regimen 1 according to the baseline CBG **(ref: appendix 2).** Monitor CBG **every hour** and adjust the insulin infusion rate according to variable rate regimen 1. Once the patient's treatment is stable i.e. 4 consecutive CBG readings between 7.0 – 11.0mmol/l monitoring may be reduced to **every 2 hours.** Return to hourly monitoring if CBG falls outside this range.

8. Document changes in the insulin infusion rate on page 2 of the CVRIII prescription (WR2170). Document CBG monitoring on page 4 and 5 of the CVRIII prescription (WR2170).

9. If CBG is not optimised between 7.0 – 11.0mmol/l after 4 hours consider changing to variable rate regimen 2 **(ref: appendix 2).** Continue monitoring CBG **every hour** and adjust the insulin infusion rate according to variable rate regimen 2. Once the patient's treatment is stable i.e. 4 consecutive CBG readings between 7.0 – 11.0mmol/l monitoring may be reduced to **every 2 hours**. Return to hourly monitoring if CBG falls outside this range.

10. If glycaemic control is still not optimised between 7.0 – 11.0mmol/l on variable rate regimen 2 after a further 4 hours then consider changing to variable rate regimen 3 **(ref: appendix 2).**. Continue monitoring CBG **every hour** and adjust the insulin infusion rate according to variable rate regimen 3. Once the patient's treatment is stable i.e. 4

consecutive CBG readings between 7.0 – 11.0mmol/l monitoring may be reduced to **every 2 hours**. Return to hourly monitoring if CBG falls outside this range.

11. In the event of a patient having a hypoglycaemic episode (CBG less than 4.0mmol/l), reduce the insulin infusion rate according to the variable rate regimen being followed **(ref: appendix 2).** Treat the episode following local hypoglycaemia guidelines (please refer to WAHT-END-004). Record treatment given on page 6 of the CVRIII prescription (WR2170). Increase the frequency of CBG monitoring to every **15 minutes** until 3 consecutive readings of 4.1mmol/l or greater is obtained. Resume **hourly** monitoring thereafter.

12. Only stop the insulin infusion if persistent symptomatic hypoglycaemic episodes occur and resume the insulin infusion as soon as CBG is above 4.0mmol/l. If the patient is on variable rate regimen 2 or 3, consideration should be made to step down to variable rate regimen 1 or 2 respectively.

Seek a medical opinion if this occurs. Insulin disappears very rapidly from the circulation when intravenous insulin is discontinued. Rebound hyperglycaemia can occur after hypoglycaemia and in patients with Type 1 Diabetes Mellitus this increases the risk of ketone production and subsequent DKA.

13. Review the continued need for CVRIII at least twice daily. If a patient is eating and drinking, the underlying reason for initiation of the CVRIII is being treated and the patient is stable then consideration should be made to change to the usual diabetes management as soon as possible. The patients' usual diabetes management should be documented by the doctor or pharmacist on page 1 of the CVRIII prescription.

14. If the patient is NOT prescribed continued basal insulin do not stop the CVRIII until the patient has had their usual diabetes management i.e. either subcutaneous insulin injection, subcutaneous GLP-1 analogue injections e.g. exenatide or OHA's e.g. metformin commenced. The guidance below should be followed:

a. When the patient is eating and drinking commence the usual diabetes management, ideally at the usual administration time and stop the CVRIII 30 – 60 minutes post administration as outlined below.

b. If commencing rapid acting subcutaneous insulin e.g. Novorapid give the insulin dose with food and stop the CVRIII **30 minutes** after the first dose **(ref: appendix 1)**.

If commencing a rapid acting insulin as part of a basal bolus subcutaneous insulin regimen (usually 4 injections a day of rapid and long acting insulins) ensure a dose of long acting insulin e.g. Glargine is also given at the same time and stop the CVRIII **30 minutes** after the first dose **(ref: appendix 1)**.

c. If commencing short acting subcutaneous insulin e.g. Actrapid give the insulin dose with food and stop the CVRIII **30 minutes** after the first dose **(ref: appendix 1)**.

If commencing a short acting insulin as part of a basal bolus subcutaneous insulin regimen (usually 4 injections a day of short and long acting insulins) ensure a dose of long acting insulin e.g. Glargine is also given at the same time and stop the CVRIII **30 minutes** after the first dose **(ref: appendix 1)**.

d. If commencing a twice daily biphasic subcutaneous insulin e.g. Novomix 30, Humalog Mix 25, give the insulin dose with food and stop the CVRIII **30 minutes** after the first dose **(ref: appendix 1)**.

e. If commencing intermediate acting subcutaneous insulin e.g. Insulatard, Humulin I stop the CVRIII **1 hour** after the first dose **(ref: appendix 1)**.

f. If commencing long acting subcutaneous insulin alone e.g. Glargine, Levemir, stop the CVRIII **1 hour** after the first dose **(ref: appendix 1)**.

g. If commencing a continuous subcutaneous insulin infusion pump recommence the pump and stop the CVRIII **30 minutes later (ref: appendix 1)**. Refer the patient to the Diabetes Specialist Nurse for specialist support recommencing this insulin device.

h. Before commencing a subcutaneous GLP-1 analogue injection e.g. exenatide, refer to the Diabetes Team for advice on whether recommencement of this treatment is appropriate.

i. If commencing OHA's e.g. metformin give the dose with food and stop the CVRIII **1 hour** after the first dose.

15. **If the patient IS prescribed continued basal insulin** CVRIII can be stopped without an overlap with the usual diabetes regimen once the patient is eating and drinking. Recommence any additional components of the patients' usual diabetes management e.g. prescribe rapid acting insulin if patient is on a basal bolus regimen.

16. Once usual diabetes management is commenced, monitor CBG 2 hourly for 24 hours after stopping CVRIII, aiming to maintain CBG between 7.0 – 11.0mmol/l. Resume CBG monitoring four times daily as a minimum thereafter (pre-breakfast, pre-lunch, pre-tea and at bedtime).

17. Refer the patient to the Diabetes Specialist Nurse as appropriate following the Think Glucose assessment and referral criteria **(ref: appendix 3).**

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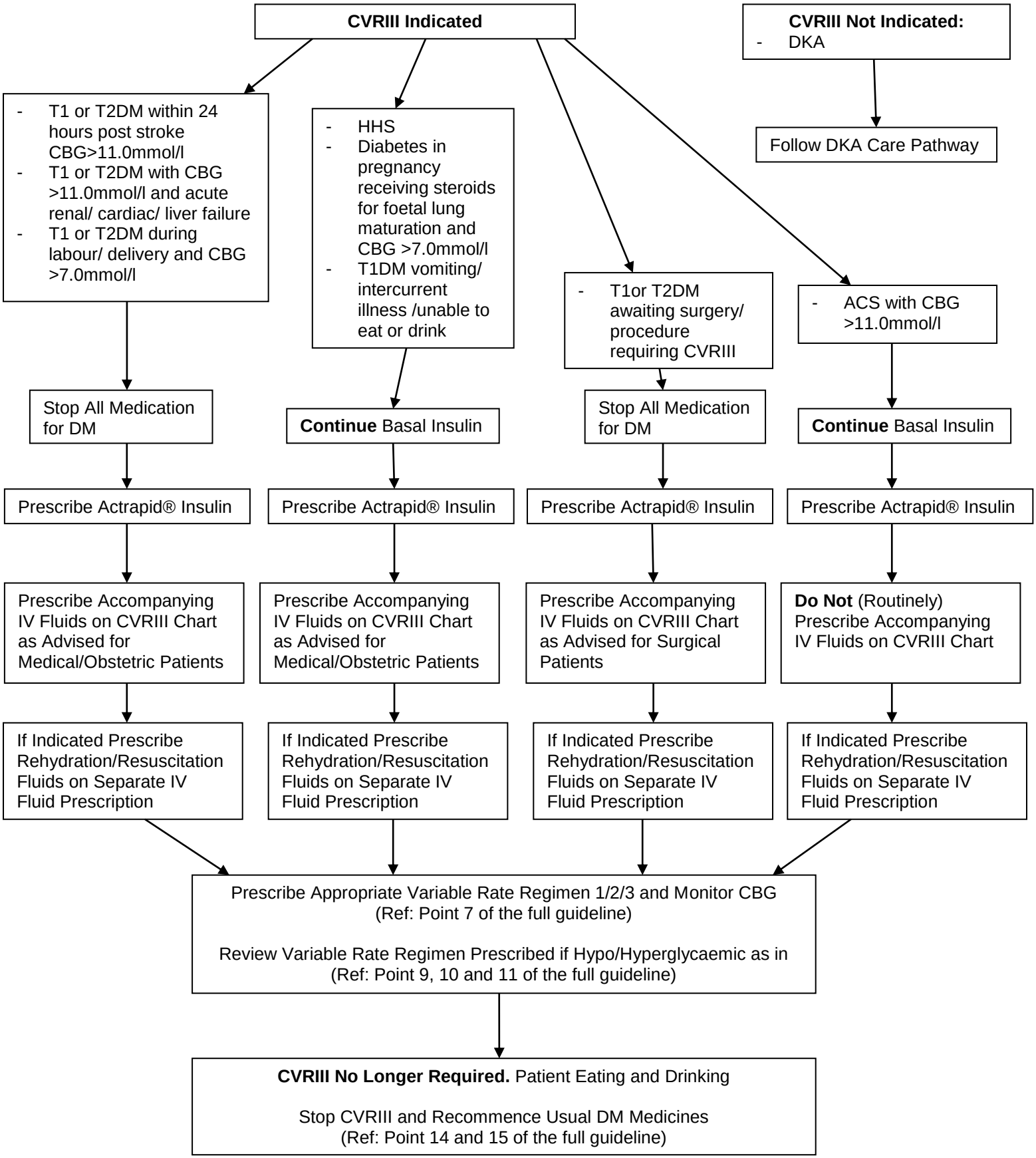
SUMMARY FLOW CHART OF THE GUIDELINE FOR THE USE OF CVRIII



APPENDICES

APPENDIX 1

Brand name	Approved name	Source
Actrapid	Soluble insulin	Human
Humulin S	Soluble insulin	Human
Hypurin neutral	Soluble insulin	Beef, Pork
Insuman rapid	Soluble insulin	Human
Apidra	Glulisine	Human
Humalog	Lispro	Human
Novorapid	Aspart	Human
Humalog Mix 25 / 50	Biphasic - lispro	Human
Humulin M3	Biphasic - isophane	Human
Hypurin 30	Biphasic - isophane	Pork
Novomix 30	Biphasic - aspart	Human
Insuman Comb 15 /25/50	Biphasic - isophane	Human
Humulin I	Isophane	Human
Hypurin isophane	Isophane	Beef, Pork
Insulatard	Isophane	Human
Insuman basal	Isophane	Human
Hypurin lente	Insulin zinc suspension	Beef
Hypurin protamine zn	Protamine zinc	Beef
Lantus	Glargine	Human
Levemir	Detemir	Human
Tresiba	Degludec	Human

- Short acting
- Rapid acting
- Biphasic
- Intermediate acting
- Long acting

APPENDIX 2

CBG (mmol/l)	***Insulin Infusion Rate*** **(units/hour - 1 unit=1ml)**		
	Regimen 1	**Regimen 2**	**Regimen 3**
Below 7.0	0.5	1	2
7.0 – 11.0 (Target range)	2	4	8
11.1 – 17.0	4	8	16
Above 17.0	6	12	24

APPENDIX 3

Referral to the Diabetes Team not usually required

- Minor, self treated hypoglycaemia
- Transient hyperglycaemia
- Simple educational need
- Routine dietetic advice
- Well controlled diabetes
- Good self management
- Routine diabetes care

Referral to the Diabetes Team may be required

- Significant educational need
- CVRIII with good glucose control
- Nil by mouth more than 24 hours post surgery
- Persistent hyperglycaemia
- Possible Type 2 Diabetes Mellitus
- Stress hyperglycaemia
- Poor wound healing
- Steroid therapy

Referral to the Diabetes Team always required

- ACS
- DKA/ HHS
- Severe hypoglycaemia
- Newly diagnosed Type 1 Diabetes Mellitus
- Newly diagnosed Type 2 Diabetes Mellitus
- CVRIII with glucose outside of limits
- Previous problems with diabetes as an inpatient
- CVRIII for over 48 hours
- Impaired consciousness
- Unable to self manage
- Parenteral or enteral nutrition
- Foot ulceration
- Sepsis
- Vomiting
- Patient request

MONITORING TOOL

How will monitoring be carried out? Clinical audit

Who will monitor compliance with the guideline? The Diabetes Team

STANDARDS	%	CLINICAL EXCEPTIONS
The inclusion criteria set out in this guideline for initiating CVRIII must be followed and the reason for initiating CVRIII documented in the medical notes and on page 1 of the CVRIII prescription	100	
The correct insulin and accompanying intravenous fluids set out in this guideline must be prescribed and administered	100	
The frequency of CBG measurement set out in this guideline for CVRIII must be followed	100	
The CVRIIII must be adjusted as set out in this guideline	100	
The CVRIIII must be stopped as set out in this guideline	100	

REFERENCES

- National Patient Safety Agency. Rapid Response Report 013. June 2010. Safer Administration of Insulin.
- Pharmacy Department, University College London Hospitals. (2007) *Injectable Medicines Administration Guide. 2nd Ed.* Oxford, Blackwell Publishing.
- The British Medical Association and The Royal Pharmaceutical Society. (2010). *British National Formulary. 60th Ed.* Basingstoke, Pharmaceutical Press.
- WAHT Medicines Policy (Policy on the Purchasing, Prescribing, Supply, Storage, Administration and Control of Medicines). WAHT-CG-580

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Alison Smith	Principal Pharmacist Medicines Safety

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Supporting Document 1 - Equality Impact Assessment Tool

To be completed by the key document author and attached to key document when submitted to the appropriate committee for consideration and approval.

		Yes/No	Comments
1.	**Does the policy/guidance affect one group less or more favourably than another on the basis of:**		
	Race	No	
	Ethnic origins (including gypsies and travellers)	No	
	Nationality	No	
	Gender	No	
	Transgender	No	
	Religion or belief	No	
	Sexual orientation including lesbian, gay and bisexual people	No	
	Age	No	
	Disability - learning disabilities, physical disability, sensory impairment & mental health problems	No	
2.	**Is there any evidence that some groups are affected differently?**	No	
3.	**If you have identified potential discrimination, are any exceptions valid, legal and/or justifiable?**	No	
4.	**Is the impact of the policy/guidance likely to be negative?**	No	
5.	**If so can the impact be avoided?**	N/A	
6.	**What alternatives are there to achieving the policy/guidance without the impact?**	N/A	
7.	**Can we reduce the impact by taking different action?**	N/A	

If you have identified a potential discriminatory impact of this key document, please refer it to Assistant Manager of Human Resources, together with any suggestions as to the action required to avoid/reduce this impact.

For advice in respect of answering the above questions, please contact Assistant Manager of Human Resources.

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Supporting Document 2 – Financial Impact Assessment

To be completed by the key document author and attached to key document when submitted to the appropriate committee for consideration and approval.

	Title of document:	Yes/No
1.	Does the implementation of this document require any additional Capital resources	No
2.	Does the implementation of this document require additional revenue	No
3.	Does the implementation of this document require additional manpower	No
4.	Does the implementation of this document release any manpower costs through a change in practice	No
5.	Are there additional staff training costs associated with implementing this document which cannot be delivered through current training programmes or allocated training times for staff	No
	Other comments:	N/A

If the response to any of the above is yes, please complete a business case and which is signed by your Finance Manager and Directorate Manager for consideration by the Accountable Director before progressing to the relevant committee for approval