Liverpool Women's NHS Foundation Trust

PERIOPERATIVE MANAGEMENT OF GYNAECOLOGY PATIENTS WITH DIABETES MELLITUS

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Version	3.0
Grade of Change	Major Revision
Summary of Changes	Inclusion of Variable Rate Insulin Infusion (VRII)

Document Type	Clinical Guideline
Coverage	Anaesthetics

Designation of Guideline Sponsor	Consultant Anaesthetists: Tamilselvi Ramanathan Dipali Verma VRII T&F Working Group
Responsible Committee	Anaesthetic Clinical Meeting

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Contents

1 Introduction

This guideline covers management of the diabetic patient from pre-operative clinic to admission, through theatre to postoperative care and resumption of usual medication. Do not use this guideline for the management of diabetes in pregnant women – refer to the Trust *Management of Gestational Diabetes* Clinical Guideline.

2 Pre-operative Clinic

2.1 Record

Type of Diabetes (1 or 2)

Diabetic medication (including doses and timings of insulin)

'Usual' BM level for patient, HbA1c if available.

Does the patient have hypoglycaemic episodes? If so, do they recognize the symptoms? (some patients on insulin have 'impaired awareness of hypoglycaemia' and should be identified).

Other co-morbidities should be identified during the pre-op assessment

2.2 Plan

If HbA1C >8.5% (69mmol mol^{-1}) or poor control, refer to anaesthetist. Consider delaying elective surgery if possible, to improve diabetes control.

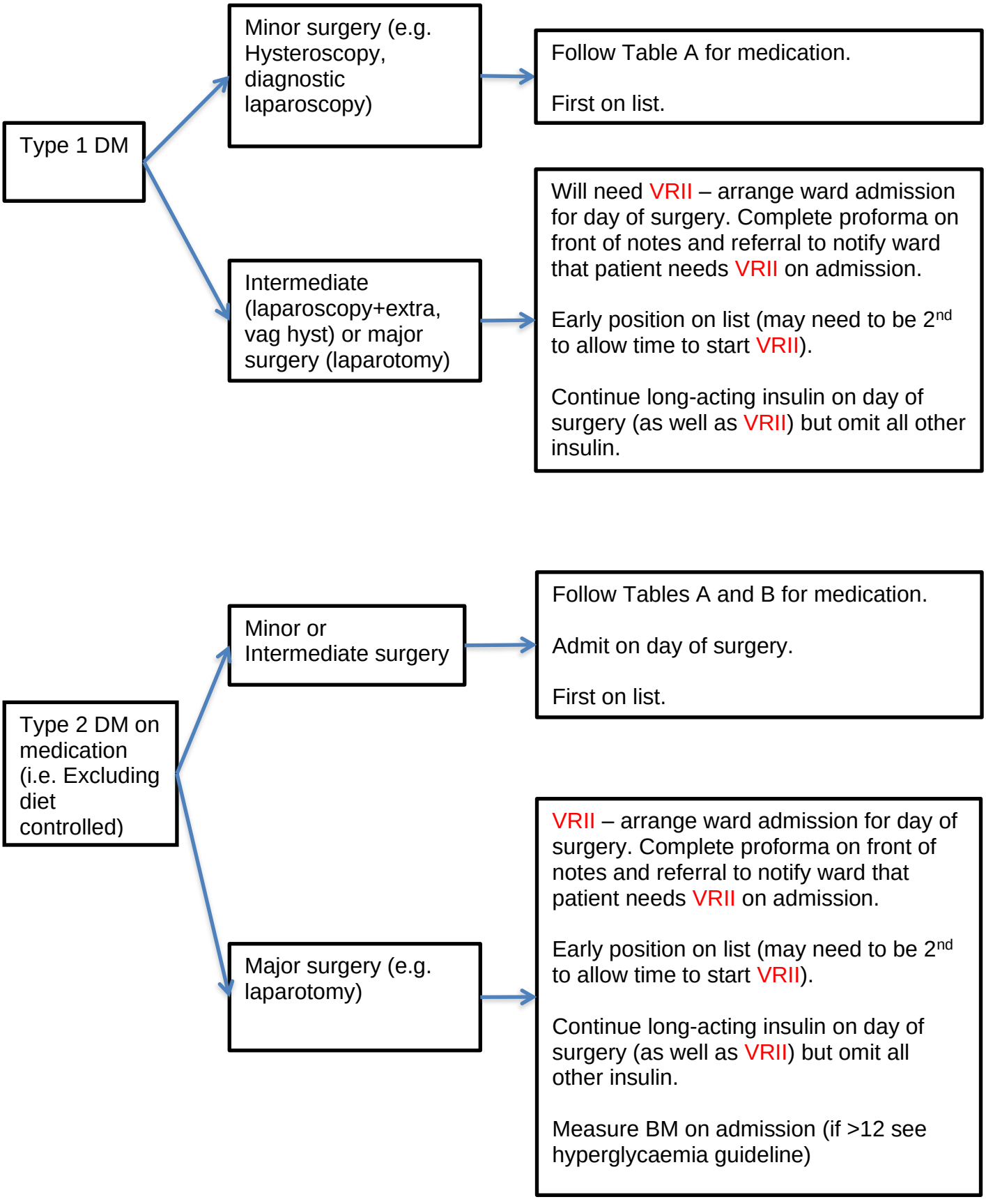
Use the flowchart and tables below to establish a plan (medications, where and when to be admitted) for the perioperative management of diabetes for each patient. A copy of this should be attached to the front of the case notes to alert ward staff prior to admission.

A copy of the fasting and medication instructions should be given to the patient. Advise the patient to travel to hospital with treatment for hypoglycaemia. If the patient has impaired awareness of hypoglycaemia, they may prefer to wait until arrival at hospital to take their medication.

Preoperative preload should not be given to diabetic patients.

NB. Discuss with the patient – diabetic patients may wish to be involved in these decisions and may be used to managing their own glycaemic control.

3 Pre-operative Plan



4 Table A: PATIENTS ON INSULIN + SHORT FASTING TIME

(No more than 1 missed meal)

DAY BEFORE SURGERY: TAKE USUAL MEDICATION

INSULIN TYPE	Day of surgery (AM list)	Day of surgery (PM list)
Once daily long or intermediate acting (e.g. Lantus, Levemir, Insulatard, Humulin I, Insuman)	If usually taken in morning: give half at breakfast time and the other half postop in the evening. If usually taken in the evening: give as usual postop.	If usually taken in morning, give full dose as usual with light breakfast. If usually taken in the evening: give usual dose postop in the evening.
Twice daily mixed (e.g. Novomix 30®, Humulin M3® Humalog Mix 25	Omit am dose Give usual evening dose if eating	Give half morning dose with light breakfast Give usual evening dose if eating
3, 4, or 5 injections daily (Basal bolus) Usually consists of 3 short acting injections and 1 long /intermediate acting.	Long-acting injection: If usually taken in morning give half dose at breakfast time and other half postop in the evening. If usually taken at night give as usual postop if eating. Short acting injections: Omit am dose, give usual postop dose when eating.	Long-acting injection: If usually taken in morning give as usual with light breakfast If usually taken at night give as usual postop if eating. Short acting injections: Give half am dose with light breakfast. Omit lunchtime dose. Give usual postop dose when eating.

NB. Patients with insulin pumps: use pump as normal, with ‘sick day’ or ‘sleep’ basal rate. Pump will usually need to be switched off before patient is anaesthetised – see below.

For all patients – Check CBG on admission and 1 -2 hourly on the day of surgery.

Aim for CBG 5-12mmol/L

5 Table B: PATIENTS ON ORAL MEDICATION + SHORT FASTING TIME

(no more than 1 missed meal)

DAY BEFORE SURGERY: TAKE USUAL MEDICATION

TABLETS	Day of surgery (AM LIST)	Day of surgery (PM LIST)
MEGLITINIDE (repaglinide, nateglinide) OR ACARBOSE	OMIT am dose	GIVE am dose if having breakfast. If no breakfast, omit.
SULPHONYLUREA (glibenclamide, glipizide, gliclazide)	Omit	
METFORMIN	Take as normal (caution if renal impairment*)	
PIOGLITAZONE	Take as normal	
DPP IV INHIBITOR (sitagliptin, saxagliptin, vildagliptin, alogliptin, linagliptin) OR GLP-1 ANALOGUE (exenatide, liraglutide, lixisenatide)	Take as normal	
SGLT-2 inhibitors (e.g. dapagliflozin, canagliflozin)	Omit the drug 24-48 hours before After a regular meal dose as usual	

*If eGFR <60ml/min/1.73m^2, omit metformin on day of surgery and for 48hrs postop.

For all patients – Check CBG on admission and 1 -2 hourly on the day of surgery.

Aim for CBG 5-12 mmol/L

6 Patients requiring IV Insulin (Variable Rate Insulin Infusion or VRII)

Use the pre-printed VRII prescription sheet to prescribe the insulin and glucose. Also prescribe this on Meditech.

Prepare the insulin infusion:

Set up a syringe driver with 50 units of Actrapid made up in 49.5 ml sodium chloride 0.9% to give a concentration of 1unit of insulin per ml.

A fresh insulin infusion should be prepared every 24 hours for immediate use.

Prepare the substrate:

Set up a volumetric pump with a 500 ml bag of 10% glucose with 20mmol potassium chloride (KCl). See 5.1 for further details on KCl replacement

A **single cannula** must be used to run the insulin and the substrate but through **two** separate infusion pumps.

Insulin must **not** be infused intravenously without substrate (glucose) – this can lead to hypoglycaemia.

Rate of infusion of the substrate:

Patient is at risk of fluid overload: infuse the 10% glucose at **40ml/hour**

Patient is not at risk of fluid overload: infuse the 10% glucose at **60ml/hour**

Rate of insulin infusion:

Patient is on 40ml/hour of substrate: start insulin infusion at **1ml/ hour**

Patient is on 60ml/hour of substrate: start insulin infusion at **2 ml/ hour**

Consider starting at 2 units higher rate of insulin in those patients whose CBG is greater than 15mmol/l or total daily insulin dose is more than 100 units.

Insulin infusion must **not** be stopped in patients with Type 1 diabetes apart from during an episode of hypoglycaemia.

Insulin must **not** be infused intravenously without substrate (glucose) – this can lead to hypoglycaemia.

Target CBG = 5 – 12 mmol/L

Check CBG hourly and adjust insulin rate according to table below (see Appendix 1);

CBG	Action
<5 mmol/l	***Decrease*** insulin rate by 1 unit/hr to a minimum of 0.5 units/hr
5-12 mmol/l (target range)	***Continue*** insulin at present rate
>12 mmol/l + not falling	***Increase*** insulin rate by 1 unit/hr

If CBG is falling rapidly (see Appendix 1);

- Stop IV Insulin
- Treat Hypo 20% glucose 100 mls or 10% glucose 200 mls
- Recheck CBG and make sure CBG>4mmol/l
- Restart Insulin at lower rate and within 20 minutes

Other drugs whilst on VRIII

Continue long-acting insulins (E.g. Levemir / Lantus / Tresiba) alongside VRIII

Discontinue other insulins and oral hypoglycaemics during VRIII

Heavier patients may require more insulin

If CBG consistently >15 and not falling, refer to anaesthetist.

Refer to appendix 1 for helpful guide on VRII implementation.

Check U&E before initiating VRII and at least twice daily when on the VRII. If serum potassium is not in the normal range, then U&Es need to be checked after each bag of glucose.

Patients with severe renal impairment may be at risk of hyperkalaemia - do not give KCl in the glucose substrate

Serum potassium 3.5 – 5 mmol/l: KCl given as part of the VRII 10% glucose substrate will suffice.

Serum potassium < 3.5 mmol/l: additional KCl will be required.
Infuse sodium chloride 0.9% with added KCl via a separate cannula at a rate appropriate for the patient, depending on their fluid status and serum potassium level.

Serum potassium > 5 mmol/l: use 10% glucose without KCl as the VRII substrate.

7 Intraoperative Care / Anaesthesia

Check CBG prior to induction of anaesthesia and then hourly if stable, or more frequently if required.

Implement WHO checklist ‘glycaemic control’

Maintain blood glucose in the range 5-12 mmol/l

If CBG is greater than 15 mmol/l you must consider +/- rule out DKA/ HHS.

Document CBG, insulin infusion rate and substrate infusion on the anaesthetic record as per RCOA recommendations.

Hartmann’s is preferred fluid if needed.

Multimodal analgesia and antiemetics to promote return to usual diet and medications.

Patients with severe renal impairment may be:

- at risk of fluid overload – hence infuse 10% glucose at 40ml/hr
- at risk of hyperkalaemia – hence use 10% glucose without KCl

Patients on subcutaneous insulin pumps: Control of these pumps is often complex and managed by the patient. These pumps must therefore be switched off during the period of time when the patient is under general anaesthesia or sedation. During this time period, VRIII should be given with appropriate monitoring.

In some cases, if the patient is remaining awake under regional anaesthesia, it may be possible to continue the pump, but the anaesthetist must discuss this with the patient and be prepared to switch the pump off and convert to VRIII if necessary. There is also a risk that s/c administered insulin may not be fully absorbed if peripheral perfusion is reduced e.g. Haemorrhage.

8 Postoperative Care

This is a high-risk time for hyperglycaemia due to the stress response, especially for emergency patients. Treatment requirements may differ in the postoperative period.

- Consult the anaesthetics team if blood glucose targets are not achieved.
- Optimise control of pain and nausea / vomiting.
- Encourage early return to eating and drinking (enhanced recovery principles)
- Allow patients to self-manage their diabetes
- Monitor electrolytes and fluid balance daily

- Inspect foot and pressure areas regularly
- Maintain meticulous infection control
- See below for resuming usual medication

VRII provides some calories but does not supplement a patient's total nutritional needs and hence must not be used for more than 48 hours.

If the patient has been on the VRII for more than 48 hours and it is anticipated that they will continue to remain 'nil by mouth' then consider initiating nasogastric (NG) feeding managed with subcutaneous insulin with a view to stopping VRII.

Switching from VRII to subcutaneous insulin

- Switch from VRII to subcutaneous insulin when the patient is able to eat and drink and their CBG level is stable.
- When switching to a BD mix insulin regimen (e.g. twice daily Novomix 30, Humalog Mix 25, Humulin M3) do so at breakfast or at tea time.
- When switching to a basal bolus regimen do so when the patient is able to have a meal.
- Allow the patient to eat, administer their insulin and stop the VRII 30 to 60 minutes after.

9 Resuming Usual Medications

<u>Oral Hypoglycaemics</u>

Restart usual doses once eating and drinking.

NB. Sulphonylureas: may need to reduce /withhold if food intake reduced
Metformin: Caution if reduced renal function

10 Management of Hyperglycaemia

Definition: Blood glucose > 12mmol/l

Check ketones. If capillary ketones >3 mmol/l or urine ketones > +++ cancel surgery and treat as DKA. Check venous blood gas. Refer to anaesthetist. (see Appendix 2)

Check U+E – calculate plasma osmolality (2xNa + urea + glu). If >320mosm l^{-1} treat as HHS (hyperglycaemic hyperosmotic state). (See Appendix 2)

If not DKA or HHS but BM >12, start VRIII

11 Management of Hypoglycaemia

Stop IV insulin.

Treat any episodes of hypoglycaemia immediately:
- 20% glucose 100ml or 10% glucose 200ml IV
- Recheck CBG in 15 minutes, make sure CBG is above 4mmol/l
- Repeat treatment if needed

Restart IV insulin once CBG > 4 mmol/l, but at a lower rate and within 20 minutes.

12 Abbreviations

BM or CBG = Capillary blood glucose
VRIII = Variable rate intravenous insulin infusion
DM= Diabetes Mellitus
DKA = Diabetic ketoacidosis
HBA1c = Glycosylated haemoglobin
eGFR = estimated glomerular filtration rate
HHS = Hyperosmolar hyperglycaemic state

13 Auditable Standards

13.1 Key Performance Indicators

Performance indicators are maintenance of glycaemic control within recommended limits during the perioperative period, avoidance of hyper and hypo glycaemia.

13.2 Audit Outcomes

% diabetic patients appropriately optimised prior to surgery.

Adherence to guideline for % of patients receiving a VRIII who should.

Frequency of CBG monitoring during admission.

% diabetic patients experiencing hyper or hypo glycaemia during admission

14 References

Management of adults with diabetes undergoing surgery and elective procedures: improving standards. Joint British Diabetes Societies, NHS Diabetes. April 2011. www.diabetes.nhs.uk

Association of Anaesthetists of Great Britain and Ireland. Peri-operative management of the surgical patient with diabetes 2015. *Anaesthesia* 2015; **70**: 1427-1440.

JBDS – IP. The use of variable rate intravenous insulin infusion (VRIII) for medical inpatients with diabetes – Oct 2014

JBDS 02 The Management of Diabetic Ketoacidosis in Adults 2021

JBDS 06 The management of the hyperosmolar hyperglycaemic state (HHS) in adults with diabetes 2022

15 Consultation and Ratification Process

This guideline was adapted from the Variable Rate Insulin Infusion (VRII) guideline at the Royal Liverpool University Hospital in consultation with Diabetic consultant.

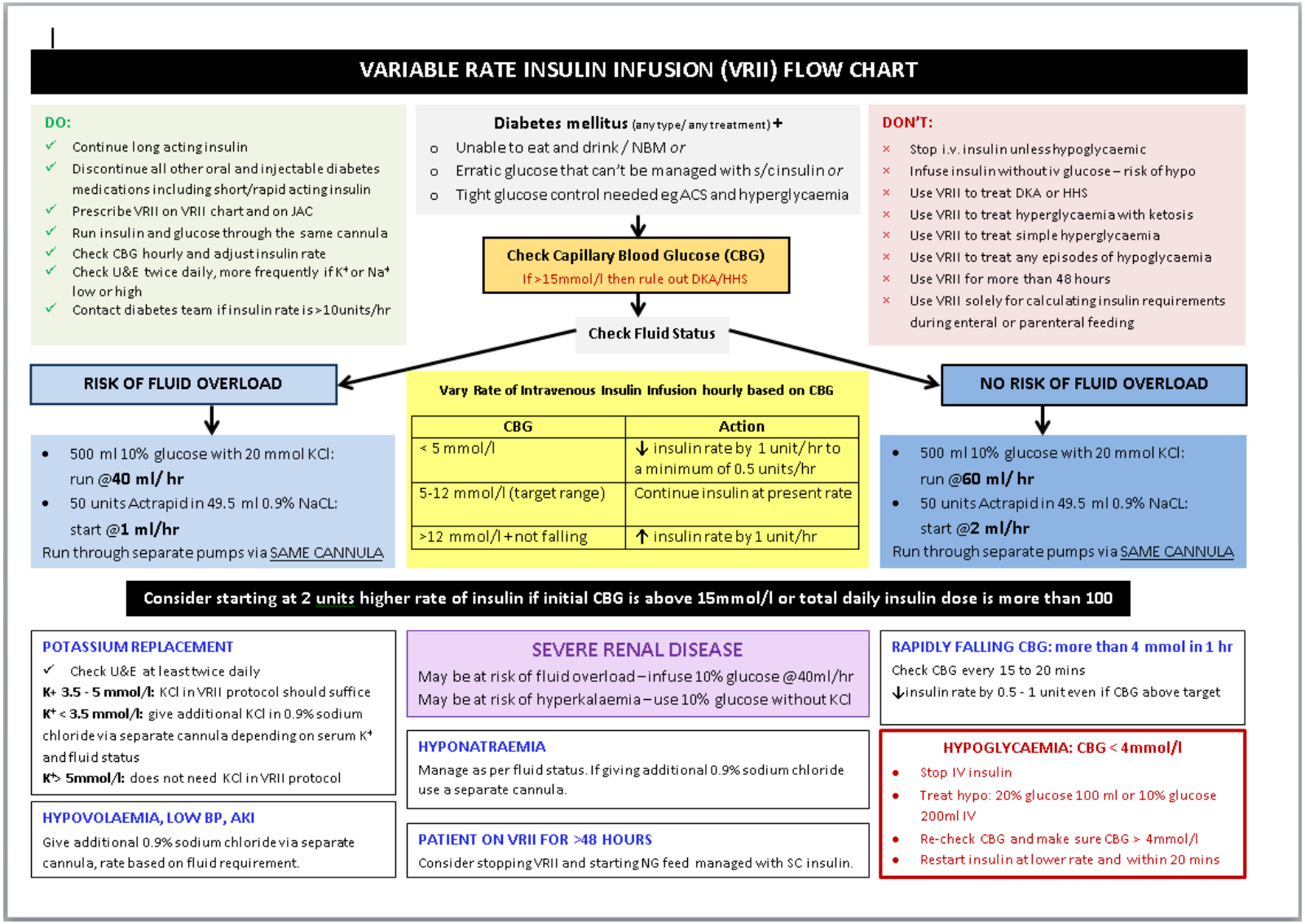
This guideline will be consulted and ratified via the Anaesthetic Department and changes will be made according to national guidance.

This guideline is not for use for diabetic management in Pregnant patients. There is separate VRII guidance for Obstetrics.

16 Intranet Classification

Tags (separated by ;)	Diabetes; infusion; Sliding Scale; insulin; oral hypoglycaemic agents; VRII; hypoglycaemia; DKA; HHA

17 Appendix 1 Variable Rate Insulin Infusion (VRIII) Quick Reference Guide



18. Appendix 2 - HYPEROSMOLAR HYPERGLYCAEMIC STATE (HHS)

[JBDS_06_HHS_care_pathway_in_adults_2022.pdf (abcd.care)]

Hyperosmolar Hyperglycaemic State (HHS) care pathway in adults

JBDS-IP Joint British Diabetes Societies for inpatient care

Clinical features (all the below)		Aims of therapy	Criteria for resolution of HHS: Holistic assessment of the following:
1) Marked hypovolaemia	A mixed picture of HHS and DKA occurs relatively frequently	1) Improvement in clinical status and replacement of all estimated fluid losses by 24 hours	1) Clinical and cognitive status is back to the pre-morbid state
2) Osmolality ≥320 mOsm/kg		2) Gradual decline in osmolality: drop of 3-8 mOsm/kg/hr	
3) Marked hyperglycaemia (≥30 mmol/L)		3) Blood glucose: aim to keep to 10-15 mmol/L in the first 24 hours	2) Osmolality <300 mOsm/kg
4) Without significant ketonaemia (≤3.0 mmol/L)		4) Avoid hypoglycaemia and hypokalaemia	3) Hypovolaemia has been corrected (urine output ≥0.5 ml/kg/hr)
5) Without significant acidosis (pH ≥7.3) and bicarbonate ≥15 mmol/L		5) Prevent harm: VTE, osmotic demyelination, fluid overload, foot ulceration	4) Blood glucose <15 mmol/L

Theme / Time	0-60 minutes	60 minutes - 6 hours	6-12 hours	12-24 hours	24-72 hours
Clinical assessment and monitoring					
Clinical status / NEWS	History/Examination, NEWS, cardiac monitoring, urine output Establish adequate intravenous lines (preferably 2 large bore IV cannulas) Discuss with outreach/ICU team early if there are markers of high severity **(see Table 1 overleaf)**			Check for continuing improvement	Expect steady recovery, patient eating and drinking, and biochemistry as it was prior to HHS Ongoing management of the precipitating cause(s) Replacement of all estimated fluid losses by 24 hours Individual BG target 6-10 mmol/L
Precipitating cause(s)	Assess for precipitating cause(s): sepsis, diabetic foot infection, treatment omissions, vulnerable adult, vascular event (myocardial infarction, stroke)			Ongoing management of the precipitating cause(s)	
Osmolality (VBG/blood) Measure/calculate (2xNa$^+$) + Glucose + Urea Aim for gradual decline of 3-8 mOsm/kg/hr	Check every hour for 6 hours Until the urea is available, calculate using (2 x Na$^+$ + glucose). Recalculate osmolality once urea is available, and then use (2 x Na$^+$ + glucose + urea)		Check every 2 hours	Check every 4 hours (if no clinical improvement then check every 2 hours)	
How to interpret osmolality results	**Check Figure 1 overleaf**	**Check Figure 1 overleaf**	**Check Figure 1 overleaf**	**Check Figure 1 overleaf**	
Blood glucose (BG) (Aim for 10-15 mmol/L in the first 24 hours)	Check every hour Fall in BG should be up to 5.0 mmol/L per hour **(check Figure 2 overleaf for details)**		**Check every hour (check Figure 2 overleaf for details)**	**Check every hour (check Figure 2 overleaf for details)**	
Interventions					
Intravenous fluids (0.9% saline) (In IV line 1) (caution in HF/CKD/BW <50 kg)	1 litre over 1 hour (caution in HF/CKD/BW <50 kg)	Aim for 2-3 litres positive balance by 6 hours	Aim for up to 6 litres positive balance by 12 hours	Reassess fluid balance to plan fluids replacement for the next 12 hours	Can be stopped if patient is eating and drinking
Insulin infusion (FRIII 0.05 units/kg/hr using Actrapid®) (In IV line 2)	Use DKA guidelines if ketonaemia (>3.0 mmol/L) or ketonuria (≥2+) Start FRIII if ketonaemia (>1.0 - ≤3.0 mmol/L) or ketonuria (<2+)	Only commence if positive fluid balance and BG plateaued on repeated measurements (>2 occasions)		Rate may need adjustment to 1 unit/hr to achieve BG target 10-15 mmol/L	VRIII if not eating and drinking Otherwise convert to subcutaneous insulin
Glucose infusion: 5% or 10% @ 125ml/hr (In IV line 2)	Not required at this stage	Only initiate if BG <14 mmol/L		Continue infusion at 125 ml/hr	Can be stopped if patient is eating and drinking
Potassium	Senior review / ICU outreach if potassium <3.5 or >6.0 mmol/L	**Check Table 2 overleaf for potassium replacement guidelines**	**Check Table 2 overleaf for potassium replacement guidelines**	**Check Table 2 overleaf for potassium replacement guidelines**	Check U&Es daily
Assessments and prevention					
Prevent harm	VTE prophylaxis (low molecular weight heparin) Assess for complications e.g. fluid overload, cerebral oedema, osmotic demyelination (deteriorating conscious level)				VTE prophylaxis until discharge Daily feet checks
Prevent hypoglycaemia	Glucose 5% or 10% at 125 ml/hr if BG <14 mmol/L				Target BG 6-10 mmol/L
Prevent foot ulceration	Daily foot checks				Daily foot checks
Refer to the inpatient diabetes team early. Escalate management if there is clinical deterioration.					Review by inpatient diabetes team before discharge

Abbreviations: BG=blood glucose; BW=body weight; CKD=chronic kidney disease; FRIII=fixed rate intravenous insulin infusion; HF=heart failure; hr=hour; ICU=intensive care unit; IV=intravenous; kg=kilograms; NEWS=national early warning score; U&Es=urea and electrolytes; VBG=venous blood gas analysis; VRIII=variable rate intravenous insulin infusion; VTE=venous thromboembolism

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Hyperosmolar Hyperglycaemic State (HHS) care pathway in adults

JBDS-IP Joint British Diabetes Societies for inpatient care

Figure 1: Managing osmolality changes during treatment of HHS

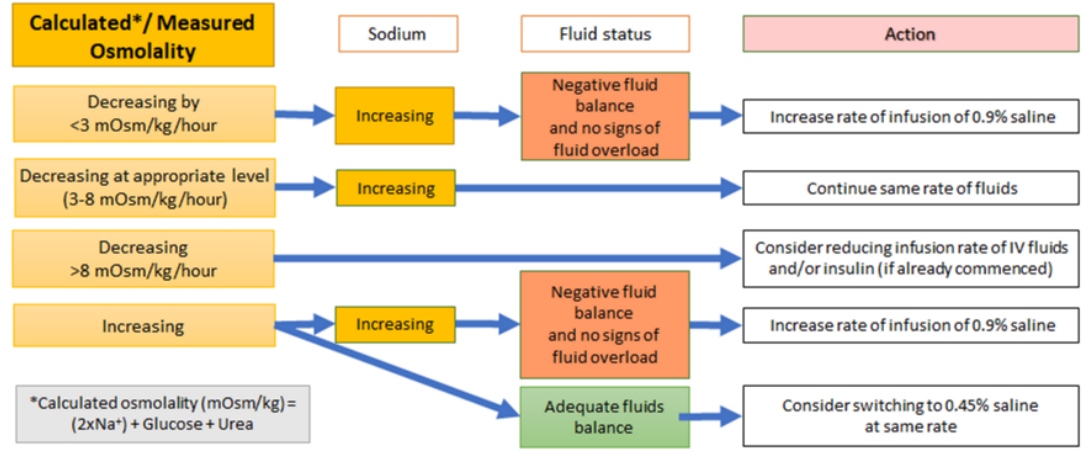
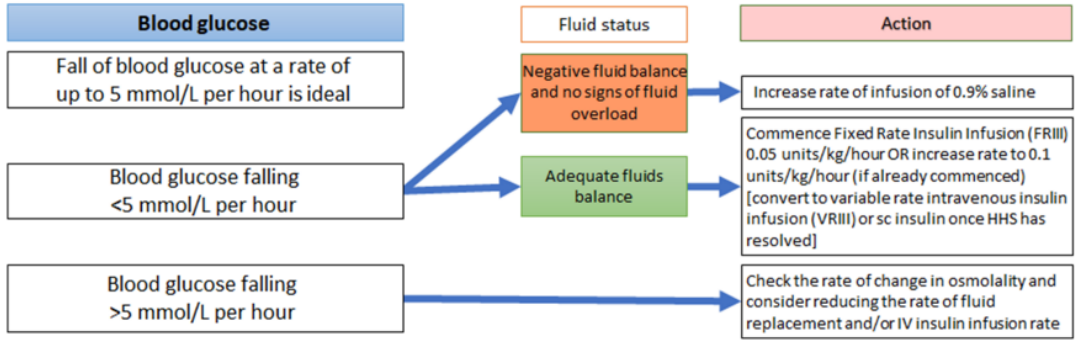


Figure 2: Managing glucose changes during treatment of HHS



If the parameters in Figures 1 and 2 above are not met, seek specialist input early to help tailor the management according to the individual's need

Table 1: Escalate to ICU/outreach if any of the following is present:

- Osmolality >350 mOsm/kg
- Sodium >160 mmol/L
- Venous/arterial pH <7.1
- Hypokalaemia (<3.5 mmol/L) or hyperkalaemia (>6 mmol/L) on admission
- Glasgow Coma Scale (GCS) <12 or abnormal AVPU (Alert, Voice, Pain, Unresponsive) scale
- Oxygen saturation <92% on air (assuming normal baseline respiratory function)
- Systolic blood pressure <90 mmHg
- Pulse >100 or <60 beats per minute
- Urine output <0.5 ml/kg/hour
- Serum creatinine >200 µmol/L and/or Acute kidney injury
- Hypothermia
- Macrovascular event such as myocardial infarction or stroke
- Other serious co-morbidity

Table 2: Potassium replacement guidelines

Potassium level in first 24 hours (mmol/L)	Potassium replacement in infusion solution
≥6.0	Senior review ICU/outreach
5.5-5.9	Nil
3.5-5.5	40 mmol/L
<3.5	Senior review ICU/Outreach. Additional potassium is required

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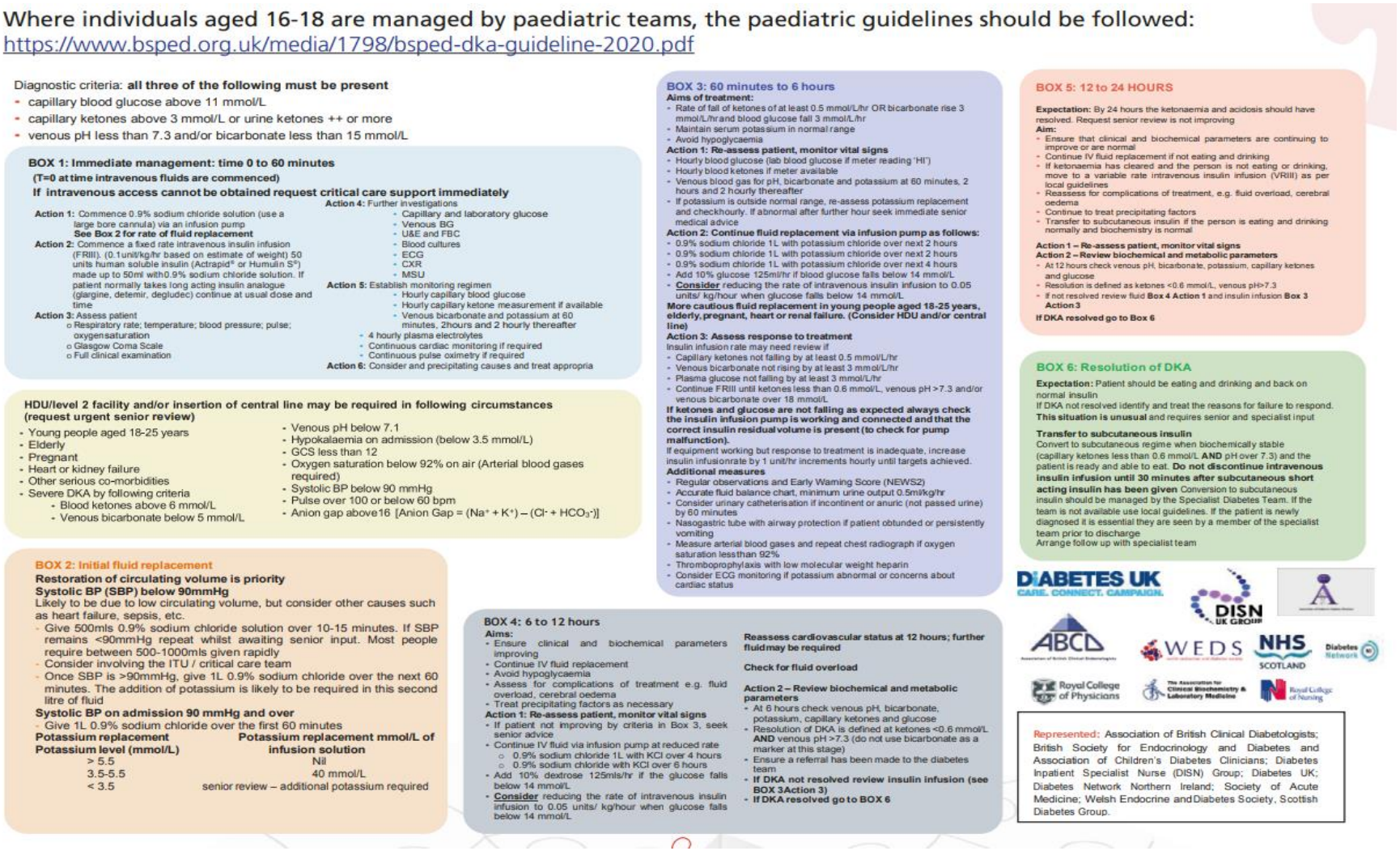
19. Appendix 3 Management of Diabetic Ketoacidosis (DKA)

[JBDS_02_DKA_Guideline_amended_v2_June_2021.pdf (abcd.care)]



Where individuals aged 16-18 are managed by paediatric teams, the paediatric guidelines should be followed:
https://www.bsped.org.uk/media/1798/bsped-dka-guideline-2020.pdf

Diagnostic criteria: **all three of the following must be present**
- capillary blood glucose above 11 mmol/L
- capillary ketones above 3 mmol/L or urine ketones ++ or more
- venous pH less than 7.3 and/or bicarbonate less than 15 mmol/L

BOX 1: Immediate management: time 0 to 60 minutes
(T=0 at time intravenous fluids are commenced)
If intravenous access cannot be obtained request critical care support immediately

Action 1: Commence 0.9% sodium chloride solution (use a large bore cannula) via an infusion pump
See Box 2 for rate of fluid replacement
Action 2: Commence a fixed rate intravenous insulin infusion (FRIII). (0.1unit/kg/hr based on estimate of weight) 50 units human soluble insulin (Actrapid® or Humulin S®) made up to 50ml with0.9% sodium chloride solution. If patient normally takes long acting insulin analogue (glargine, detemir, degludec) continue at usual dose and time
Action 3: Assess patient
- Respiratory rate; temperature; blood pressure; pulse; oxygensaturation
- Glasgow Coma Scale
- Full clinical examination

Action 4: Further investigations
- Capillary and laboratory glucose
- Venous BG
- U&E and FBC
- Blood cultures
- ECG
- CXR
- MSU

Action 5: Establish monitoring regimen
- Hourly capillary blood glucose
- Hourly capillary ketone measurement if available
- Venous bicarbonate and potassium at 60 minutes, 2hours and 2 hourly thereafter
- 4 hourly plasma electrolytes
- Continuous cardiac monitoring if required
- Continuous pulse oximetry if required

Action 6: Consider and precipitating causes and treat appropria

HDU/level 2 facility and/or insertion of central line may be required in following circumstances (request urgent senior review)
- Young people aged 18-25 years
- Elderly
- Pregnant
- Heart or kidney failure
- Other serious co-morbidities
- Severe DKA by following criteria
  - Blood ketones above 6 mmol/L
  - Venous bicarbonate below 5 mmol/L
- Venous pH below 7.1
- Hypokalaemia on admission (below 3.5 mmol/L)
- GCS less than 12
- Oxygen saturation below 92% on air (Arterial blood gases required)
- Systolic BP below 90 mmHg
- Pulse over 100 or below 60 bpm
- Anion gap above16 [Anion Gap = $(Na^+ + K^+) - (Cl^- + HCO_3^-)$]

BOX 2: Initial fluid replacement
Restoration of circulating volume is priority
Systolic BP (SBP) below 90mmHg
Likely to be due to low circulating volume, but consider other causes such as heart failure, sepsis, etc.
- Give 500mls 0.9% sodium chloride solution over 10-15 minutes. If SBP remains <90mmHg repeat whilst awaiting senior input. Most people require between 500-1000mls given rapidly
- Consider involving the ITU / critical care team
- Once SBP is >90mmHg, give 1L 0.9% sodium chloride over the next 60 minutes. The addition of potassium is likely to be required in this second litre of fluid

Systolic BP on admission 90 mmHg and over
- Give 1L 0.9% sodium chloride over the first 60 minutes

Potassium replacement Potassium level (mmol/L)	Potassium replacement mmol/L of infusion solution
> 5.5	Nil
3.5-5.5	40 mmol/L
< 3.5	senior review – additional potassium required

BOX 3: 60 minutes to 6 hours
Aims of treatment:
- Rate of fall of ketones of at least 0.5 mmol/L/hr OR bicarbonate rise 3 mmol/L/hrand blood glucose fall 3 mmol/L/hr
- Maintain serum potassium in normal range
- Avoid hypoglycaemia

Action 1: Re-assess patient, monitor vital signs
- Hourly blood glucose (lab blood glucose if meter reading 'HI')
- Hourly blood ketones if meter available
- Venous blood gas for pH, bicarbonate and potassium at 60 minutes, 2 hours and 2 hourly thereafter
- If potassium is outside normal range, re-assess potassium replacement and checkhourly. If abnormal after further hour seek immediate senior medical advice

Action 2: Continue fluid replacement via infusion pump as follows:
- 0.9% sodium chloride 1L with potassium chloride over next 2 hours
- 0.9% sodium chloride 1L with potassium chloride over next 2 hours
- 0.9% sodium chloride 1L with potassium chloride over next 4 hours
- Add 10% glucose 125ml/hr if blood glucose falls below 14 mmol/L
- **Consider** reducing the rate of intravenous insulin infusion to 0.05 units/ kg/hour when glucose falls below 14 mmol/L

More cautious fluid replacement in young people aged 18-25 years, elderly, pregnant, heart or renal failure. (Consider HDU and/or central line)

Action 3: Assess response to treatment
Insulin infusion rate may need review if
- Capillary ketones not falling by at least 0.5 mmol/L/hr
- Venous bicarbonate not rising by at least 3 mmol/L/hr
- Plasma glucose not falling by at least 3 mmol/L/hr
- Continue FRIII until ketones less than 0.6 mmol/L, venous pH >7.3 and/or venous bicarbonate over 18 mmol/L

If ketones and glucose are not falling as expected always check the insulin infusion pump is working and connected and that the correct insulin residual volume is present (to check for pump malfunction).
If equipment working but response to treatment is inadequate, increase insulin infusionrate by 1 unit/hr increments hourly until targets achieved.

Additional measures
- Regular observations and Early Warning Score (NEWS2)
- Accurate fluid balance chart, minimum urine output 0.5ml/kg/hr
- Consider urinary catheterisation if incontinent or anuric (not passed urine) by 60 minutes
- Nasogastric tube with airway protection if patient obtunded or persistently vomiting
- Measure arterial blood gases and repeat chest radiograph if oxygen saturation lessthan 92%
- Thromboprophylaxis with low molecular weight heparin
- Consider ECG monitoring if potassium abnormal or concerns about cardiac status

BOX 4: 6 to 12 hours
Aims:
- Ensure clinical and biochemical parameters improving
- Continue IV fluid replacement
- Avoid hypoglycaemia
- Assess for complications of treatment e.g. fluid overload, cerebral oedema
- Treat precipitating factors as necessary

Action 1: Re-assess patient, monitor vital signs
- If patient not improving by criteria in Box 3, seek senior advice
- Continue IV fluid via infusion pump at reduced rate
  - 0.9% sodium chloride 1L with KCl over 4 hours
  - 0.9% sodium chloride with KCl over 6 hours
- Add 10% dextrose 125mls/hr if the glucose falls below 14 mmol/L
- **Consider** reducing the rate of intravenous insulin infusion to 0.05 units/ kg/hour when glucose falls below 14 mmol/L

Reassess cardiovascular status at 12 hours; further fluidmay be required

Check for fluid overload

Action 2 – Review biochemical and metabolic parameters
- At 6 hours check venous pH, bicarbonate, potassium, capillary ketones and glucose
- Resolution of DKA is defined at ketones <0.6 mmol/L **AND** venous pH >7.3 (do not use bicarbonate as a marker at this stage)
- Ensure a referral has been made to the diabetes team
- **If DKA not resolved review insulin infusion (see BOX 3Action 3)**
- **If DKA resolved go to BOX 6**

BOX 5: 12 to 24 HOURS
Expectation: By 24 hours the ketonaemia and acidosis should have resolved. Request senior review is not improving
Aim:
- Ensure that clinical and biochemical parameters are continuing to improve or are normal
- Continue IV fluid replacement if not eating and drinking
- If ketonaemia has cleared and the person is not eating or drinking, move to a variable rate intravenous insulin infusion (VRIII) as per local guidelines
- Reassess for complications of treatment, e.g. fluid overload, cerebral oedema
- Continue to treat precipitating factors
- Transfer to subcutaneous insulin if the person is eating and drinking normally and biochemistry is normal

Action 1 – Re-assess patient, monitor vital signs
Action 2 – Review biochemical and metabolic parameters
- At 12 hours check venous pH, bicarbonate, potassium, capillary ketones and glucose
- Resolution is defined as ketones <0.6 mmol/L, venous pH>7.3
- If not resolved review fluid **Box 4 Action 1** and insulin infusion **Box 3 Action 3**

If DKA resolved go to Box 6

BOX 6: Resolution of DKA
Expectation: Patient should be eating and drinking and back on normal insulin
If DKA not resolved identify and treat the reasons for failure to respond.
This situation is unusual and requires senior and specialist input

Transfer to subcutaneous insulin
Convert to subcutaneous regime when biochemically stable (capillary ketones less than 0.6 mmol/L **AND** pH over 7.3) and the patient is ready and able to eat. **Do not discontinue intravenous insulin infusion until 30 minutes after subcutaneous short acting insulin has been given** Conversion to subcutaneous insulin should be managed by the Specialist Diabetes Team. If the team is not available use local guidelines. If the patient is newly diagnosed it is essential they are seen by a member of the specialist team prior to discharge
Arrange follow up with specialist team

DIABETES UK CARE. CONNECT. CAMPAIGN. DISN UK GROUP ABCD WEDS NHS SCOTLAND Diabetes Network Royal College of Physicians The Association for Clinical Biochemistry & Laboratory Medicine Royal College of Nursing

Represented: Association of British Clinical Diabetologists; British Society for Endocrinology and Diabetes and Association of Children's Diabetes Clinicians; Diabetes Inpatient Specialist Nurse (DISN) Group; Diabetes UK; Diabetes Network Northern Ireland; Society of Acute Medicine; Welsh Endocrine and Diabetes Society, Scottish Diabetes Group.

20. Version Control Sheet

Version	Date	Author	Status	Comment
1	Jan 12	Anaesthetics	Archived	Guideline Creation
2.4	Jan 15	Helen McNamara	Archived	Reviewed and updated
2.5	Sept 16	Helen McNamara	Archived	Minor Update
2.6	Nov 16	Helen McNamara	Archived	Minor amendment
2.7	Nov 17	Helen McNamara	Archived	Minor amendment to Patients on subcutaneous insulin pumps:
2.8	Mar 18	Tamilselvi Ramanathan	Archived	Minor amendment to include obstetric guideline and Royal Liverpool hospital guideline under associated documents
2.9	Sept 18	Tamilselvi Ramanathan	Archived	Minor amendment to include Variable Rate Intravenous Insulin Infusion (VRIII) Sliding Scale as an appendix, and DKA as an appendix
2.10	May 19	Tamilselvi Ramanathan	Archived	Minor amendment to state VRIII to be used only in HDU
2.11	Dec 19	Tamilselvi Ramanathan	Archived	Amendment agreed within departmental meeting for VRIII infusion
2.12	May 20	Tamilselvi Ramanathan	Archived	Updated SGLT-2 inhibitors
3	Nov 2023	Tamilselvi Ramanathan, Dipali Verma, VRII T&F group	Current	Changing from GKI to VRIII in Gynaecology

21. Monitoring Compliance with the Guideline

Audit outcomes	Target	How will the audit outcomes be Monitored?	Responsible committee for monitoring audit outcomes and action plans	Frequency of guideline monitoring	Frequency of action plan monitoring	Lead
% diabetic patients appropriately optimised prior to surgery.	100%	Departmental audit	Effectiveness senate	5 yearly	5 yearly	H McNamara
Adherence to guideline for % of patients receiving VRIII who should.	100%	Departmental audit	Effectiveness senate	5 yearly	5 yearly	H McNamara
Frequency of CBG monitoring during admission	100%	Departmental audit	Effectiveness senate	5 yearly	5 yearly	H McNamara
% diabetic patients experiencing hyper or hypo glycaemia during admission	100%	Departmental audit	Effectiveness senate	5 yearly	5 yearly	H McNamara/ Audit lead