

## Procedure for Management of Diabetic Ketoacidosis (DKA) and Hyperosmolar Hyperglycaemic State (HHS) Protocol

### Protocol:

#### Objective

- To ensure a high standard of prompt, safe, intensive management and care of adult patients presenting with Diabetic Ketoacidosis (DKA) or Hyperosmolar Hyperglycaemic State (HHS). Goals of therapy include to:
  - Correct dehydration
  - Correct acidosis and abolish ketosis
  - Reduce blood glucose to near normal
  - Restore electrolyte balance
  - Avoid potential complications of therapy
  - Identify and treat any precipitating event
- This procedure outlines the requirements for the following care elements
  - [Patient assessment and diagnosis](#)
  - [Treatment and monitoring](#)
  - [Equipment and preparation](#)
  - [Observations](#)
  - [Discharge planning](#)
  - [Documentation requirements](#)

#### Principles of Action

- Complete a rapid patient clinical and biochemical assessment
- Patients who present to ED with a BGL >14mmol/L are to have ketones measured and if  $\geq 3.0$  be considered triage category 2
- Diagnose and identify the severity of DKA or HHS
- Refer patient to the **Endocrine Team** within one (1) hour of presentation (Registrar, Mon – Fri page 6810 or Endocrine Consultant on call, via switchboard).
- Initiate an insulin infusion for those patients diagnosed with moderate or severe DKA and for those diagnosed with HHS according to [Table 1 - DKA / HHS Severity Scale](#) at diagnosis and [Table 2 - Insulin infusion rates & Rehydration fluids for DKA and HHS](#)
- Replace fluid deficit according to [Table 2](#) and maintain accurate fluid balance records
- Closely monitor and restore electrolyte/potassium balance remembering body potassium deficit in acidosis
- Identify precipitating causes such as, new diagnosis of diabetes, insulin omission, concurrent illness/infection, trauma, malfunction of subcutaneous insulin pumps
- In patients with insulin infusions for DKA and HHS:
  - Measure blood glucose hourly or more frequently depending on their condition
  - Measure pH, bicarbonate, potassium (blood gas) initially, then two (2) hourly until pH above 7.3.
  - Measure blood ketones/ $\beta$ -OHB (in DKA), osmolality (in HHS), magnesium and phosphate initially, then four (4) hourly until pH above 7.3.
- Provide patient with information regarding their condition, treatment and cause of symptoms
- Patients with:
  - **Mild DKA** can be managed in 8N using subcutaneous insulin injections **OR** using an insulin infusion post 'step-down' from ICU or ED, **so long as the following criteria are met:**

- The patient no longer clinically requires four (4) hourly pathology monitoring (e.g. blood gases, potassium, bicarbonate, magnesium, phosphate)
- The acidosis has resolved, pH>7.3
- The treating Endocrinologist has approved patient transfer to 8N

Patients requiring more frequent monitoring (other than hourly Blood Glucose Level – BGL) are not appropriate for ward environments.

- **Moderate DKA** will be managed in Intensive Care Unit (ICU) under the supervision of the Endocrine Consultant
- **Severe DKA and HHS** will be managed in ICU under the supervision of the Endocrine Consultant

**NOTE:** Patients who develop DKA or HHS in other ward areas will be managed according to this procedure by the primary care team who should immediately consult the **Endocrine Team** (Registrar, Mon-Fri, page 6810 OR Endocrine Consultant, 24-hours, via switchboard). The Senior Endocrine Consultant on-call will decide where the patient should be transferred to for ongoing DKA or HHS management.

#### Definitions

<b>Blood Glucose Level (BGL)</b>	Measure of glucose in the blood in mmol/L.
<b>Blood Glucose Monitoring (BGM)</b>	Measurement and documentation of the Blood Glucose Level (BGL) using a capillary (finger-prick) blood sample and point of care (bedside) blood glucose meter.
<b>Diabetic Ketoacidosis (DKA)</b>	Medical emergency most common in type 1 diabetes, characterised by hyperglycaemia, ketosis and metabolic acidosis.
<b>Hyperglycaemia</b>	BGL persistently >11.0mmol/L for more than twenty-four (24) hours.
<b>Hyperglycaemic Hyperosmolar (Non-ketotic) state (HHS)</b>	Severe hyperglycaemia (usually >33.0mmol/L) (without elevated ketones) resulting in a raised blood osmolality and dehydration, sufficient to impair consciousness.
<b>Hypoglycaemia</b>	Blood glucose level (<4.0mmol/L) with or without symptoms.
<b>Intravenous Insulin Infusion</b>	Solution of regular-acting insulin and sodium chloride or dextrose infused intravenously to regulate blood glucose levels.
<b>Subcutaneous Insulin Pump</b>	Patient-held subcutaneous insulin delivery device, also known as a Continuous Subcutaneous Insulin Infusion that delivers a continuous basal infusion (24hrs) of rapid-acting insulin, along with user operated (bolus) dose insulin when required.
<b>Type 1 Diabetes</b>	Autoimmune condition where the pancreas can no longer produce any insulin due to beta cell destruction (insulin deficient).
<b>Type 2 Diabetes</b>	Condition where the pancreas is not producing enough insulin, commonly accompanied by resistance to insulin action.
<b>Ketones</b>	Group of three acidic chemical substrates (acetone, acetoacetate and beta-hydroxybutyrate) that are metabolic by-products of unrestrained lipolysis resulting in metabolic acidosis.
<b>Beta-hydroxybutyrate (β-OHB)</b>	Predominant ketone in diabetic ketoacidosis (DKA). Measured using a blood sample (not urine).

### Roles and Responsibilities

All MOs and RNs working in ED, ICU, and X8N have a responsibility to understand the management of DKA and HHS, to update their knowledge and skills and to comply with current evidence based practice and policies.

#### The Medical Officer (MO) is responsible for the following

- Completing an urgent initial assessment of all patients with diabetes, or suspected diabetes, who present with DKA/HHS (see [Box A](#))
- Diagnosing and identifying the severity of DKA or HHS based on [Table 1](#)
- Prescribing the insulin infusion on the *DKA/HHS Intravenous Insulin Infusion & Management Chart- P186* (See Appendix 1) and rehydration fluids on the *Fluid Balance Chart P460*
- Referring patients with DKA / HHS within one (1) hour to the Endocrine Team (Registrar, page 6810 or Endocrinologist on call, via switchboard) for advice and consultation regarding insulin infusion management
- Meticulous monitoring of blood gases, pH, bicarbonate, potassium 2 hourly and, magnesium, phosphate, osmolality (HHS), blood ketones/ β-OHB (DKA) 4 hourly until pH above 7.3
- Monitoring electrolytes, urea and creatinine 2 to 4 hourly until clinically indicated otherwise
- Monitoring hydration status: peripheral perfusion, capillary refill, mucous membranes, skin turgor pulse rate, blood pressure, central venous pressure, haemoglobin and urine output
- Reviewing BGLs and insulin infusion adjustments as per [Table 2](#)
- Adhering to medication policies & procedures: [Medication Administration](#) and [High Risk Medicines Management](#)
- Documenting assessment and management in the patient's progress notes.
- Contacting the **Endocrine Team** (Registrar, page 6810, or Endocrinologist On-call, via switchboard) **BEFORE** ceasing the insulin infusion to enable correct transition to subcutaneous insulin therapy

#### The Registered Nurse (RN) is responsible for the following

- Preparing the insulin infusion according to this procedure
- Administration of insulin infusion ONLY following a written order by the MO on the *DKA/HHS Intravenous Insulin Infusion Management Chart P186*
- Administration of the insulin infusion that has been checked by two RNs, one of whom must be IV accredited, or an RN and MO
- Checking BGL hourly and adjusting the insulin infusion rate according to [Table 2](#). A second RN/MO/Pharmacist must check all infusion rate changes (as per Administration of Intravenous Medicines Procedure)
- Reporting to MO when BGL <15 to enable hydration fluid to be switched to 5% glucose
- Monitoring blood ketones (β-OHB)(in DKA) initially, then 4 hourly or as directed by MO
- Maintaining strict fluid balance records and measuring urine output hourly
- Identifying, reporting and treating hypoglycaemia according to [Hypoglycaemia Management Protocol](#)
- Monitoring vital signs - blood pressure, pulse, respirations, pulse oximetry, level of consciousness and temperature, 2 hourly or as directed by MO, or more frequently depending on the patient's condition
- Adhering to medication policies & procedures: [Medication Administration](#) and [High Risk Medicines Management Policy](#)

#### Nursing Unit Managers are responsible for the following

- Ensuring nursing staff are competent in the preparation, monitoring and management of intravenous insulin infusions for DKA and HHS
- Ensuring essential equipment is available on the clinical unit for nursing staff to prepare and monitor insulin infusions
- Ensuring all patients who experience intravenous insulin infusion related medication incidents and/or monitoring related

incidents during their hospitalisation must be reported in the Incident Information Management System (RiskMan™)

- Reviewing RiskMan™ data trends for the ward in relation to insulin infusion related medication incidents and/or monitoring related incidents on a quarterly basis and for developing and implementing strategies toward reducing these incidents

#### The Endocrine Consultant is responsible for the following

- Reviewing DKA / HHS patients regularly and advising on best practice treatment
- Deciding with the ICU and the primary care team when it is safe to transfer a patient with DKA from ICU to 8N for ongoing care

#### Process

#### Patient Assessment & Diagnosis

<b>Box A: Urgent initial assessment</b>	
<b>Action 1</b>	ABC with measurement of RR, temp, pulse, BP, GCS, pulse oximetry, cardiac monitoring and insert IV cannula.
<b>Action 2</b>	Blood glucose and blood ketones - $\beta$ -OHB (see <a href="#">Table 1</a> ).
<b>Action 3</b>	Venous blood for: FBC, EUC, $\beta$ -OHB, glucose, CMP, LFT, lipids, lipase, HbA1c, osmolality, Blood gas for: $\text{HCO}_3^-$ , pH, calculate anion gap $[(\text{Na}^+ + \text{K}^+) - (\text{Cl}^- + \text{HCO}_3^-)]$ and corrected serum sodium (Na, serum Na + $\frac{1}{4}$ of serum glucose), lactate (as another cause for acidosis). Consider blood cultures. Assess need for arterial line.
<b>Action 4</b>	Confirm diagnosis of DKA or HHS (see <a href="#">Table 1</a> ).
<b>Action 5</b>	The presence of one or more of the following may indicate severe DKA or HHS – obtain immediate Endocrine Team review (Registrar page 6810 or Consultant on-call via switchboard) and consider prompt admission to ICU:
	<ul style="list-style-type: none"> <li>• Blood ketones (<math>\beta</math>-OHB ) above 3 mmol/L</li> <li>• Venous bicarbonate level below 5mmol/L</li> <li>• Venous or arterial pH below 7</li> <li>• Anion gap above 16</li> <li>• Osmolality &gt;300</li> </ul> <ul style="list-style-type: none"> <li>• GCS less than 12</li> <li>• Oxygen saturation below 92% on air (assuming normal baseline resp function)</li> <li>• Systolic BP below 90mmHg</li> <li>• Pulse over 100 or below 60 bpm</li> </ul>

**TABLE 1: DKA/HHS Severity Scale at Diagnosis**

Categories	DKA			HHS
	Mild	Moderate	Severe	
Plasma Glucose	>14mmol/L	>14mmol/L	>14mmol/L	> 33mmol/L
pH	7.25 – 7.3	7.0 – 7.24	<7.0	-
Bicarbonate	15 -18mmol/L	10 - 14.9mmol/L	<10mmol/L	-
Blood Ketones ( $\beta$ -OHB)	0.6 to 3mmol/L	>3mmol/L	>3mmol/L	-
Serum Osmolality	Normal	Normal	Normal	>300mOsm/kg
Anion gap	>10mmol/L	>12mmol/L	>12mmol/L	-
Alteration in sensoria	Alert	Alert/drowsy	Stupor/coma	Stupor/coma
Treatment	<b>No Infusion</b> subcutaneous insulin injections	<b>Infusion Advised</b> (see <a href="#">Table 2</a> )	<b>Infusion Advised</b> (see <a href="#">Table 2</a> )	<b>Infusion Advised</b> (see <a href="#">Table 2</a> )
Initial Ward/Unit	8N or manage as an outpatient if not vomiting	ICU as per Endocrine Consultant	ICU as per Endocrine Consultant	ICU as per Endocrine Consultant

(Adapted from International Society for Paediatric and Adolescence Diabetes (ISPAD) Clinical Practice Consensus Guidelines 2006-2007, Ped. Diab. 2007:8:28-43)

#### Treatment & Monitoring

<b>BOX B: Immediate management upon diagnosis: (0 to 60 minutes)</b> (t=0 at time intravenous fluids are commenced)	
<b>Aims</b>	<ul style="list-style-type: none"> <li>• <b>Suppress ketogenesis and commence fluid replacement</b></li> <li>• <b>Maintain serum potassium in normal range (monitor and replace potassium as it may fall rapidly)</b></li> <li>• <b>Avoid hypoglycaemia</b></li> <li>• <b>Ensure that an Endocrine Consultant has been notified</b></li> </ul>
	<p><b>Obtain urgent IV access (2 cannulae or consider if Central Venous Access Device (CVAD) is needed) and commence IV fluids</b></p> <ul style="list-style-type: none"> <li>• <b>Systolic BP on admission above 90mmHg</b></li> </ul>

Action 1	<p>Prescribe rehydration fluids according to <a href="#">Table 2</a> and patient's clinical condition. Avoid sodium chloride 0.9% as it can worsen the acidosis.</p> <ul style="list-style-type: none"> <li>• <u>Systolic BP on admission below 90mmHg</u></li> </ul> <p>Hypotension is likely to be due to low circulating volume, but consider other causes such as heart failure or sepsis. In DKA give 500mL of Hartmanns over 15 minutes. In HHS give 500mL of Albumex as preference, otherwise Hartmanns or sodium chloride 0.45%, over 15 minutes. If SBP remains below 90mmHg this may be repeated whilst awaiting senior input. In practice most patients require between 1L to 2L of fluid in the first hour. Once SBP above 90mmHg follow fluid replacement schedule according to <a href="#">Table 2</a> and patient's clinical condition.</p>
Action 2	<p><b>Potassium/electrolyte replacement</b></p> <ul style="list-style-type: none"> <li>• Hypokalaemia and hyperkalaemia are life threatening conditions and are common in DKA.</li> <li>• Potassium is often high on admission but falls precipitously upon treatment with insulin.</li> <li>• Commence potassium replacement (potassium chloride) early unless potassium &gt;5mmol/L or oliguric.</li> <li>• As a general rule, give up to 10 mmol/hr if potassium is &lt; 4 mmol/L and up to 5 mmol/hr if potassium 4-5 mmol/L (see <a href="#">High Risk Medicines Management Policy</a> )</li> <li>• Potassium must never be given by bolus injection.</li> <li>• Potassium must always be given by continuous infusion via an infusion pump. Higher concentrations than 60mmol in 1000ml or 10mmol in 100ml of isotonic saline in a premixed bag, require administration via a central venous catheter.</li> <li>• The maximum dose should not exceed 20mmol/hr under any circumstances.</li> <li>• See <a href="#">High Risk Medication Policy</a> for further information on concentrations, dosing and monitoring.</li> <li>• If phosphate is low consider replacement with potassium dihydrogen phosphate.</li> <li>• If magnesium is low consider replacement with magnesium sulfate.</li> <li>• Always check kidney function and closely monitor urinary output before starting/and during potassium replacement.</li> </ul>
Action 3	<p><b>Refer to Diabetes Team</b></p> <p>Diabetes Registrar Mon-Fri (page 6810) or Diabetes Consultant on-call 24 hours (via switchboard).</p>
Action 4	<p><b>Commence intravenous insulin infusion</b></p> <ul style="list-style-type: none"> <li>• Prescribe on the <i>DKA/HHS Intravenous Insulin Infusion &amp; Management Chart – P186</i>.</li> <li>• Use 250 units human soluble insulin (Actrapid) in 250mL 5% Glucose - adhere strictly to preparation guidelines - see <a href="#">Box F</a>.</li> <li>• Commence rate according to blood glucose level – see <a href="#">Table 2</a>. Aim for blood glucose level reduction of 3-5mmol/L/hr until BGL approaching target of 6 -12 mmol/L.</li> </ul>
Action 5	<p><b>Complete a full history and clinical examination. Things to consider:</b></p> <ul style="list-style-type: none"> <li>• Known diabetes and previous presentations</li> <li>• Medications: Record - <ul style="list-style-type: none"> <li>◦ S/C Insulin: Type Dose/s and timing</li> <li>◦ S/C insulin pump: last bolus dose &amp; basal rates</li> <li>◦ Oral anti-diabetic medications</li> <li>◦ Other medications: corticosteroids</li> <li>◦ Recreational drug use</li> </ul> </li> <li>• Recent illness/infections</li> <li>• Recent home blood glucose levels</li> <li>• Symptoms of hyperglycaemia</li> <li>• Complications of diabetes</li> <li>• Consider urinary catheter if acidotic or dehydrated. Measure urine output hourly.</li> </ul>
Action 6	<p><b>Consider further investigations</b></p> <p>Investigate possible precipitants and treat accordingly: CXR, ECG, urine cultures, cardiac enzymes, blood cultures, periodontal disease and lower leg/foot ulcer.</p>
Action 7	<p><b>Establish monitoring regimen</b></p> <ul style="list-style-type: none"> <li>• Hourly blood glucose (formal glucose if blood glucose meter reading 'HI' &gt;33.3mmol/L).</li> <li>• Monitor pH, potassium &amp; bicarbonate every two (2) hours AND magnesium, phosphate, blood ketones (in DKA), osmolality (in HHS) every four (4) hours, more frequently if clinically indicated, until pH &gt;7.3</li> <li>• Record all results on the <i>DKA/HHS Intravenous Insulin Infusion &amp; Management Chart – P186</i>.</li> <li>• Continuous pulse oximetry and consider cardiac monitoring as indicated.</li> <li>• Vital signs and neurology (GCS) every two (2) hours, more frequently if clinically indicated.</li> <li>• Urine output and strict fluid balance chart hourly.</li> </ul>
Action 8	<p>Prescribe thromboprophylaxis as per the <a href="#">SVH Venous Thromboembolism (VTE) Procedure</a>, particularly patients with HHS.</p>
Action 9	<p><b>Ward location</b></p> <p>Patients should be managed initially in ED unless urgent transfer to ICU required. Once stabilised transfer to appropriate unit as per <a href="#">Table 1</a>. The Medical Registrar / Senior on Wards is to be notified for all DKA/HHS patients leaving the ED / ICU after hours.</p>
	<p><b>Do not use intravenous bicarbonate.</b></p>

<b>Action 10</b>	Do not give intravenous bicarbonate because of the danger of fatal hypokalaemia. If pH <7.1 and not improving contact Endocrine/ICU Consultant (if patient in ICU) who will advise on management.
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**BOX C: Management from: (60 minutes to 6 hours)**

<b>Aims</b>	<ul style="list-style-type: none"> <li>• Maintain serum potassium greater than 4 mmol/L</li> <li>• Avoid hypoglycaemia</li> </ul>
<b>Action 1</b>	<p><b>Re-assess patient and continue to monitor vital signs: ensure that patient has had an Endocrine review.</b></p> <ul style="list-style-type: none"> <li>• Consider urinary catheterization if incontinent or oliguric (i.e. not passed urine by 60 minutes).</li> <li>• If oxygen saturation falling measure ABGs and request (or repeat) CXR.</li> <li>• Document accurate fluid balance including urine output (minimum desired output=0.5mL/kg/hr).</li> </ul>
<b>Action 2</b>	<p><b>Review metabolic parameters</b></p> <ul style="list-style-type: none"> <li>• Hourly blood glucose.</li> <li>• Monitor pH, potassium &amp; bicarbonate every two (2) hours AND magnesium, phosphate, blood ketones (in DKA) osmolality (in HHS) every four (4) hours, more frequently if clinically indicated, until pH &gt;7.3.</li> <li>• Record all results on the <i>DKA/HHS Intravenous Insulin Infusion &amp; Management Chart – P186</i>.</li> </ul>
<b>Action 3</b>	<p><b>Assess response to treatment with insulin infusion, rate may need review if:</b></p> <ul style="list-style-type: none"> <li>• Blood ketones (<math>\beta</math>-OHB), bicarbonate or glucose not correcting as expected, check IV lines, volumes of fluid remaining, check for insulin infusion pump malfunction.</li> <li>• If insulin infusion working and connected but glucose response inadequate, MO to consider increasing the insulin infusion rate by 1 units/hr increments until targets achieved (6-12 mmol/L) after which revert to infusion rates as per <a href="#">Table 2</a>.</li> <li>• Continue infusion until pH &gt;7.3, bicarbonate <math>\geq</math> 18mmol/L and patient able to eat and drink.</li> <li>• <b>CONSULT</b> Endocrine Team <b>BEFORE</b> ceasing the infusion for conversion to subcutaneous insulin.</li> </ul>
<b>Action 4</b>	<p><b>Continue fluid and potassium/electrolyte replacement via infusion pump</b></p> <ul style="list-style-type: none"> <li>• Follow fluid replacement as per <a href="#">Table 2</a>. When blood glucose is less than 15mmol/L replace hydration fluid with 5% Glucose – review fluid prescription to avoid fluid overload.</li> <li>• If potassium outside reference range, reassess potassium replacement and check hourly. If abnormal after further hour seek Senior Endocrine Consultant/ICU Consultant advice.</li> <li>• If phosphate is low consider replacement with potassium dihydrogen phosphate.</li> <li>• If magnesium is low consider replacement with magnesium sulfate.</li> </ul>

**BOX D: Management from: (6 to 12 hours)**

<b>Aims</b>	<ul style="list-style-type: none"> <li>• Ensure clinical and biochemical parameters are continuing to improve or are normal</li> <li>• Continue IV fluid replacement and IV insulin infusion until acidosis corrected and patient is eating and drinking</li> <li>• Avoid hypoglycaemia</li> <li>• Re-assess for complications of treatment such as fluid overload and cerebral oedema</li> <li>• Treat precipitating factors as necessary</li> </ul>
<b>Action 1</b>	<p><b>Re-assess patient, monitor vital signs</b></p> <ul style="list-style-type: none"> <li>• If patient not improving, seek advice from Endocrine Team, Registrar (Mon-Fri page 6810) or Endocrine Consultant on-call (via switchboard).</li> </ul>
<b>Action 2</b>	<p><b>Review biochemical and metabolic parameters</b></p> <ul style="list-style-type: none"> <li>• Hourly blood glucose</li> <li>• Every two (2) hours check pH, potassium, bicarbonate and every 4 hours check magnesium, phosphate, blood ketones (in DKA), osmolality (in HHS), until pH &gt;7.3.</li> <li>• Resolution of DKA defined as pH &gt;7.3 and bicarbonate <math>\geq</math>18</li> <li>• If DKA not resolved refer to Action 3 in <a href="#">Box C</a>.</li> </ul>
<b>Action 3</b>	When DKA resolved review insulin infusion to maintain capillary glucose 6-12 mmol/L and consult Endocrine Team regarding commencement of a subcutaneous insulin regimen <b>BEFORE</b> ceasing infusion.

**BOX E: Management from: (12 to 24 hours)**

<b>Aims</b>	<ul style="list-style-type: none"> <li>• Ensure clinical and biochemical parameters are continuing to improve or are normal</li> <li>• Continue IV fluid replacement and IV insulin infusion until acidosis corrected and patient able to eat</li> <li>• Avoid hypoglycaemia</li> <li>• Re-assess for complications of treatment such as fluid overload and cerebral oedema</li> <li>• Treat precipitating factors as necessary</li> </ul>
<b>Action</b>	Re-assess patient, monitor vital signs



<b>1</b>	<ul style="list-style-type: none"> <li>If patient not improving seek advice from Endocrine Consultant on-call (via switchboard).</li> <li>When patient well ensure referral is made to Diabetes CNC (page 6157) for discharge planning.</li> </ul>
<b>Action 2</b>	<p><b>Review biochemical and metabolic parameters</b></p> <ul style="list-style-type: none"> <li>Hourly blood glucose</li> <li>Every two (2) hours check pH, potassium, bicarbonate and every 4 hours check magnesium, phosphate, blood ketones (in DKA), osmolality (in HHS), until pH &gt;7.3.</li> <li>Resolution of DKA defined as pH &gt;7.3 and venous bicarbonate ≥18</li> <li>If remains acidotic check blood ketones (β-OHB) as there may be an alternative cause of persisting acidosis.</li> <li>If DKA not resolved refer to Action 3 in Box C and contact Endocrine Registrar (page 6810) or Endocrine Consultant on-call, 24-hours, via switchboard.</li> </ul>
<b>Action 3</b>	<p>When DKA resolved review insulin infusion to maintain capillary glucose 6-12 mmol/L the <b>Endocrine Consultant</b> will switch to subcutaneous insulin when all of the following are met:</p> <ul style="list-style-type: none"> <li>Acidosis has resolved, pH &gt;7.3 mmol/L and bicarbonate ≥ 18 mmol/L.</li> <li>BGL is within target range i.e. &lt;12 mmol/L.</li> <li>Electrolytes are within normal parameters.</li> <li>The patient is able to tolerate diet and is not vomiting.</li> <li>A subcutaneous insulin regimen has been prescribed.</li> </ul>
<b>Action 4</b>	<p>By 24 hours the ketonaemia and acidosis should have resolved. If not normalised, seek Endocrine Consultant review.</p> <p>If the patient has newly diagnosed diabetes it is essential that they are reviewed by the Endocrine Team (Registrar p. 6810) and Diabetes CNC (page 6157) prior to discharge.</p>

(Adapted from the Joint British Diabetes Societies Inpatient Care Group guideline "The Management of Diabetic Ketoacidosis in Adults" Mar2010)

**Table 2 - Insulin infusion rates & Rehydration fluids for DKA and HHS**

	BGL (mmol/L)	Insulin Infusion Fluid (5% Glucose) Rate (mL/hr)	Insulin rate (units/hr)	Rehydration Fluids
<b>DKA Insulin Infusion Rates</b>	≥ 25- - - - - ▶	5 mL	5 units	Hartmann's
	20-24.9- - - - ▶	4 mL	4 units	Hartmann's
	15-19.9- - - - ▶	3 mL	3 units	Hartmann's
	10-14.9- - - - ▶	2 mL	2 units	5% Glucose***
	<10- - - - - ▶	1 mL	1 units	5% Glucose***
	<4****- - - - ▶	0.5mL	0.5 units	5% Glucose***
<b>**HHS Insulin Infusion Rates</b>	≥25- - - - - ▶	2 mL	2 units	Albumex, Hartmann's or sodium chloride 0.45%*
	≥ 20 - 24.9- - - ▶	1 mL	1 units	
	< 20- - - - - ▶	Consider subcutaneous insulin		

\* Take cardiopulmonary status into account prior to prescribing hydration fluid for patients with HHS to prevent fluid overload. Correct serum sodium for glucose level [i.e.  $Se Na = (Glucose/4) + Na$ ].

\*\*Rapid correction of electrolytes/osmolality may be associated with mental deterioration. Aim for blood glucose level reduction of 3-5mmol/L/hr until approaching target BGL of 6.0-12.0mmol/L.

\*\*\* In some circumstances 10% Glucose may be required.

\*\*\*\* Indicates hypoglycaemia. Notify MO immediately AND treat according to '[SVH Hypoglycaemia Management Protocol](#)'. DO NOT turn insulin infusion off as likely to result in worsening acidosis.

**Equipment & Preparation**

<b>BOX F: IV Insulin Infusion &amp; Hydration Fluid Preparation</b>	
<b>Equipment</b>	<ol style="list-style-type: none"> <li>1x 3mL Penfill cartridge of soluble regular insulin e.g. Actrapid</li> <li>3mL syringe and 23G needle (for drawing up insulin and loading into fluid). <b>DO NOT USE insulin syringe as needle too short to adequately deliver insulin into infusion fluid.</b></li> <li>250mL bag of 5% Glucose</li> <li>1 blue medication additive label for Intravenous Use Only</li> <li>5mL syringe and 5mL sodium chloride 0.9% for injection (to flush IV cannula)</li> <li>Micropore tape to secure line</li> <li>2 x IV ALARIS infusion sets</li> <li>2 x ALARIS Care Fusion pumps – one for insulin infusion and one for hydration fluids</li> <li>1 litre bag of hydration fluid as ordered by MO</li> <li>Alco-wipes</li> <li>Blood Glucose Monitor (Roche Performa™)</li> <li>Blood Glucose/Ketone Monitor (Statstrip Express™) (Also used for glucose in ICU)</li> </ol>
	<ul style="list-style-type: none"> <li>Explain procedure to patient.</li> <li>Observe standard precautions and hand hygiene throughout procedure and when assembling</li> </ul>

<b>Insulin Infusion Preparation</b>	<p>equipment.</p> <ul style="list-style-type: none"> <li>• Draw up 250 units (2.5mL) of Actrapid insulin using a 23G needle and 3 mL syringe and inject into 250mL of 5% Glucose (<b>appropriately checked with second RN or MO</b>).</li> <li>• Gently but thoroughly mix contents of bag.</li> <li>• Attach completed additive label to bag.</li> <li>• Insert ALARIS infusion set and prime and clamp line.</li> <li>• <b>IMPORTANT: Slowly run and discard 50mL of insulin/Glucose solution through the infusion set before connection and commencement of the infusion (Note: Insulin molecules attach to plastic tubing and need to saturate tubing before infusion commencement).</b></li> <li>• Flush patient's IV cannula with 5mL sodium chloride 0.9% for injection.</li> <li>• Attach infusion set to the infusion pump, connect to patient's IV cannula and commence infusion rate as outlined in <a href="#">Table 2</a></li> <li>• Document details of the insulin infusion on the <b>DKA/HHS Intravenous Insulin Infusion &amp; Management Chart – P186</b> and in progress notes.</li> </ul>
<b>Hydration fluid preparation</b>	<ul style="list-style-type: none"> <li>• Observe standard precautions and hand hygiene throughout procedure and when assembling equipment</li> <li>• Select hydration fluid as prescribed by MO (<b>checked by second RN or MO</b>).</li> <li>• Insert ALARIS infusion set and prime and clamp line.</li> <li>• Flush patient's IV cannula with 5mL sodium chloride 0.9% for injection.</li> <li>• Attach infusion set to the infusion pump, connect to patient's IV cannula and commence hydration infusion at prescribed rate.</li> <li>• Document details of the hydration fluid on the <b>Fluid Balance Chart No - P460</b> and in progress notes.</li> </ul>
<b>NOTE</b>	<ul style="list-style-type: none"> <li>• Insulin infusion and hydration fluid are <b>ALWAYS</b> run as two separate lines.</li> </ul>

### Observations

<b>Monitoring Regimen</b>				
<b>Observations</b>	<b>Initially</b>	<b>Hourly</b>	<b>Two (2) hourly until pH &gt;7.3</b>	<b>Four (4) hourly until pH &gt;7.3</b>
Blood Glucose	x	x		
Urine output / Fluid Balance		x		
pH, bicarbonate, potassium (blood gas)	x		x	
Vital Signs	x		x	
GCS	x		x	
Blood Ketones (DKA), osmolarity (HHS)	x			x
Phosphate, magnesium (CMP)	x			x
Cardiac monitoring	Ongoing for those in severe DKA, otherwise as directed by MO			
<b>Action</b>				
<ul style="list-style-type: none"> <li>• Contact the MO to review the patient if a 'HI' capillary glucose reading is obtained via the AccuChek™ Performa™ meter (BGL is greater than 33.3mmol/L). A formal blood glucose sample must be taken to determine the precise blood glucose level.</li> <li>• Notify MO when BGL is less than 15mmol/L. The RMO should replace IV hydration fluids with 5% Glucose.</li> <li>• A BGL less than 4 mmol/L indicates hypoglycaemia and must be treated immediately: <ul style="list-style-type: none"> <li>○ Contact MO <b>urgently</b> to review patient, a BGL less than 3-4 mmol/L with a decreased level of consciousness = <b>call Rapid Response</b> (as per <i>Clinical Emergency Response System - CERS Procedure</i>).</li> <li>○ As a standing order, the insulin infusion rate may be reduced to 0.5 units/hour (0.5 mL/hour) as part of treatment</li> <li>○ <b>NEVER TURN OFF THE INSULIN INFUSION as likely to result in worsening acidosis.</b></li> <li>○ Treat with oral or IV glucose as per SVH Hypoglycaemia Management Protocol.</li> </ul> </li> <li>• Check patency of all lines. If cannula begins to infiltrate, contact the MO immediately for re-siting.</li> </ul> <p><b>NB: If ketones and glucose are not falling as expected always check that the insulin infusion is connected and functioning correctly.</b></p>				

### Discharge Planning

- All patients who have been admitted with DKA or HHS (with or without insulin infusions) should be reviewed by the Endocrine Registrar (page 6180) and the Diabetes CNC (page 6157) prior to discharge
- The Endocrine Team and Diabetes CNC will assess the cause/s of the DKA/HHS episode, and, with the patient, will formulate a diabetes management plan that will aim to prevent recurrent future episodes
- Patients with newly diagnosed diabetes will need to continue their stabilisation and education under supervision of the Diabetes Centre multidisciplinary team (or equivalent elsewhere) but may be discharged to complete the process as an outpatient

### Disposal of Waste/Equipment

- Dispose of equipment in accordance with SVH Waste Management Policy
- Wash hands post procedure

### Documentation

Document:

- The insulin infusion prescription and administration on the *DKA/HHS Intravenous Insulin Infusion Management Chart - P186*
- Potassium prescription and administration on the:
  - *IV Potassium Replacement Chart – P234 (ICU)*
  - *Fluid Balance Chart – P460 (ED)*
- Patient assessment, plan of care, care delivery and outcomes in the Patient Healthcare Record
- Any abnormalities, actions taken, outcomes and who was notified of the abnormalities in the patient's progress notes
- The managing medical team is to assess and document the patient's progress daily in the patient's healthcare record
- Maintain Fluid Balance Chart No P460

#### Compliance:

Compliance will be monitored annually by auditing the patient's healthcare record. This audit will be a randomly selected group of patients who required Insulin Infusion for DKA/HHS. These patients will be identified from coding.

The audit outcomes will be monitored and actioned by the Integrated Care Quality Committee.

The practice audit will cover the following key principles:

1. Insulin Infusion prescription is documented on DKA/HHS Intravenous Insulin Infusion Management Chart - (P186) per protocol.
2. Insulin Infusion BGL monitoring attended hourly.
3. Insulin Infusion was administered and infusion altered according to protocol.
4. Rehydration fluids administered according to protocol.
5. Biochemical monitoring attended according to protocol.
6. Potassium prescribed according to protocol.
7. Thromboprophylaxis prescribed in HHS.
8. Endocrine Team contacted prior to ceasing insulin infusion.

**Risk Rating: Medium**

#### Appendices:

- [DKA/HHS Bundle Audit Tool](#)
- [DKA/HHS Intravenous Insulin Infusion Management Chart - P186](#)

#### Standard:

##### National Standards

- NSQHS Standard 4 - Medication Safety
- EQulP National Standard 12.1 - Assessment and care planning ensure that the current and ongoing needs of the consumer/patient are identified.

#### References:

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#### Risk Rating:

Not set

#### Focus Area(s):

- Acute and High Dependency
- Medicines & Other Therapeutics

#### Linked PP:



- [Blood Glucose and Blood Ketone Monitoring Protocol](#)
- [High Risk Medicines Management Policy](#)
- [Hypoglycaemia Management Protocol](#)
- [Inpatient Diabetes Model of Care Policy](#)
- [Medication Administration Protocol](#)
- [Venous Thromboembolism Prevention Protocol](#)

**Departments:**

- Geriatric and Ambulatory Medicine Program

**Revision History:**

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Committee(s):	<a href="#">SVHN Patient Safety &amp; Quality Committee</a>
Approved By:	Chief Executive
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