**GUIDELINE**

**ADULT HYPEROSMOLAR HYPERGLYCAEMIC STATE (HHS)**

Disclaimer: This document does not override decision based on clinical judgement and experience of the prescriber.

**SCOPE**

<table>
<thead>
<tr>
<th>Site</th>
<th>Service/Department/Unit</th>
<th>Disciplines</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sir Charles Gairdner Hospital</td>
<td>All areas</td>
<td>Medical, Nursing, Allied Health</td>
</tr>
</tbody>
</table>

This guideline must NOT be used in children (<18 years). Seek advice from senior clinician or diabetes specialty unit in cases of uncertainty. Continuous cardiac monitoring must be instituted when intravenous potassium chloride is administered at a rate of greater than 10mmol/hour (WA Policy for Intravenous Potassium 0444/13)

**INTRODUCTION PURPOSE**

These guidelines are for the treatment of adults with Hyperosmolar Hyperglycaemic State (HHS), previously known as hyperosmolar non-ketotic coma (HONK).

Seek advice from senior clinician or diabetes specialty unit in cases of uncertainty

**DEFINITIONS**

**Hyperosmolar Hyperglycaemic State (HHS)**

An extreme metabolic derangement characterised by severe hyperglycaemia, hyperosmolality (manifested by hypernatraemia and haemoconcentration) without evidence of substantial ketosis.

**GUIDELINE**

Staff must adhere to the following procedure when managing an adult patient with Hyperosmolar Hyperglycaemic State (HHS).

The guideline must be adapted to the clinical situation where necessary.

All management must be recorded in Adult Hyperosmolar Hyperglycaemic State Guidelines and Management Record (MR 838), see appendix 1.

**DIAGNOSIS CRITERIA**

- Hypovolaemia
- Marked hyperglycaemia (>30 mmol/L)
- Increased plasma osmolality (> 320 mmol/kg or mosm/kg)
- Calculated osmolality = 2(Sodium) + glucose + urea (all in mmol/L)
  (N.B. osmolality and osmolarity units can be used interchangeably in this clinical scenario)

If the patient does not meet any of the above criteria, re-consider diagnosis

**NOTE:** If the patient has Type 1 diabetes or is hyperglycaemic (blood glucose level >11mmol/L) with:

- acidosis (venous bicarbonate <18 and/or pH <7.35), and
- blood (capillary) ketones ≥3mmol/L

Follow the SCGH Adult Diabetes Ketoacidosis Management Guidelines (include LINK to DKA guideline).
NEW PRINCIPLES FOR THE MANAGEMENT OF HHS

1. Correct hypovolaemia first by using 0.9% sodium chloride solution for resuscitation. Do not use Hartmann’s or colloid. Expect an initial rise in sodium level.

2. Closely monitor electrolytes, as there is a high risk of abnormalities and cerebral oedema.

3. Treat hyperglycaemia with intravenous (IV) fluids only.

4. Only commence insulin when:
   - blood glucose is no longer falling with IV fluids, or
   - if significant ketonaemia (blood (capillary) ketones: >1 mmol/L).


Consider critical care admission and senior clinician review if one or more of the following is present:

- Osmolality >350 mosmol/kg
- Systolic Blood Pressure (SBP) <90 mmHg
- Plasma Sodium (Na⁺) > 160 mmol/L
- Pulse <60 or >100 bpm
- pH < 7.1
- Hypo or hyperkalaemia
- Urine output < 0.5 ml/kg/hr
- Glasgow Coma Scale (GCS) < 12 or abnormal AVPU score
- O₂ saturation < 92% on room air
- Other serious co-morbidity

ESSENTIAL ASSESSMENT TO DETERMINE THE SEVERITY OF HHS

The following assessment must be carried out to determine the severity of HHS:

- Blood ketones
- Blood glucose
- Venous bicarbonate
- Venous (or arterial) pH
- Potassium - beware of initial low potassium; if level <3.5mmol/L, call for senior medical advice immediately
- Serum osmolality
- Serum Creatinine
- Systolic Blood pressure (BP)
- Glasgow Coma Scale (GCS)

INTRAVENOUS FLUID REPLACEMENT

Assess severity of dehydration in the patient and use sodium chloride 0.9% (+/- potassium) for fluid replacement WITHOUT insulin initially.

This alone will lower blood glucose which will in turn, reduce osmolality.

- Aim to achieve positive fluid balance of 3 to 6 litres within the first 12 hours of intervention and 100% of estimated fluid losses by 24 hours.
- Typically, fluid losses approximate 110 to 220 mL/kg (i.e. 11 to 22 L for a 100kg patient).
- Provided osmolality is decreasing appropriately, continue patient on sodium chloride 0.9%, even if plasma sodium is increasing.
- All fluid, after the first bag, should contain potassium chloride unless urine output is <0.5 mL/kg/hr or serum potassium remains > 5.5 mmol/L.
- Caution is needed, particularly in the elderly, where rapid rehydration may precipitate heart failure.
Table 1: Example of fluid regimen (speed up initial fluids as clinically indicated)

<table>
<thead>
<tr>
<th>Bag</th>
<th>Fluid</th>
<th>Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st</td>
<td>0.9% sodium chloride</td>
<td>1000mL over 1 hour</td>
</tr>
<tr>
<td>2nd</td>
<td>Sodium chloride 1L with 40mmol potassium chloride</td>
<td>1000mL over next 2 hours</td>
</tr>
<tr>
<td>3rd</td>
<td>Sodium chloride 1L with 40mmol potassium chloride</td>
<td>1000mL over next 4 hours</td>
</tr>
<tr>
<td>4th</td>
<td>Sodium chloride 1L with 40mmol potassium chloride</td>
<td>1000mL over next 4 hours</td>
</tr>
<tr>
<td>5th</td>
<td>Sodium chloride 1L with 40mmol potassium chloride</td>
<td>1000mL over next 6 hours</td>
</tr>
</tbody>
</table>

**INTRAVENOUS POTASSIUM MANAGEMENT**

- Initial potassium is often high, particularly if patient has renal impairment
- Caution needs to be taken if urine output is less than 0.5mL/kg/hr
- Insulin and fluid replacement often cause an acute drop in potassium, particularly within the first 1 to 2 hours

**Rate of potassium infusion through peripheral lines must be no more than 20mmol potassium chloride per hour in HHS. The patient must be on a cardiac monitor if receiving > 10mmol/hr potassium chloride, or if serum potassium is >5.5mmol/L or <3.0mmol/L**

Table 2: Medical action according the patient’s potassium level

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potassium &gt; 5.5 mmol/L</td>
<td>Nil replacement required</td>
</tr>
<tr>
<td>Potassium 3.5 to 5.5 mmol/L</td>
<td>20mmol to 40 mmol potassium (premixed bags only) **Maximum rate 20mmol/hr with cardiac monitoring</td>
</tr>
<tr>
<td>Potassium &lt; 3.5 mmol/L</td>
<td>Senior medical review required immediately</td>
</tr>
</tbody>
</table>

**INSULIN MANAGEMENT**

Only start low dose IV insulin 0.05 units/kg/hour (e.g. 80kg = 4 units/hr) if:

- Significant ketonaemia - bedside blood (capillary) ketones >1 mmol/L  
  OR
- Blood glucose level falling at a rate of less than 5 mmol/hr despite adequate fluid replacement
  - Add 50 units of Actrapid® to 50mL of sodium chloride 0.9%
  - Once commenced, if blood glucose is falling at a rate less than 5mmol/L per hour with adequate fluid balance, increase the insulin rate to 0.1 units/kg/hr
  - Beware of hypoglycaemia
  - Aim to keep blood glucose at 10 to 15 mmol/L in the first 24 hours
  - Once blood glucose falls below 14 mmol/L, commence 10% glucose at 125mL/hr **and continue sodium chloride 0.9% solution as clinically indicated**
  - **Patients must always continue their usual long-acting basal insulin at the usual dose**

**MONITORING**

Check every hour for the first 6 hours, then 2 hourly if satisfactory response to interventions:

- Repeat plasma sodium, potassium, urea and blood glucose testing
- Calculate serum osmolality [2(sodium)+glucose+urea] and plot on the osmolality graph on MR 838 (see Figure 1 for image)
Assessment for complications of treatment e.g. fluid overload, cerebral oedema or central pontine myelinolysis (as indicated by a deteriorating conscious level)

If osmolality is increasing (or falling at a rate of <3 mosmol/kg/hr) and sodium is increasing, check fluid balance:
- If inadequate, increase the sodium chloride 0.9% infusion rate
- If adequate, consider changing to sodium chloride 0.45% infused at the same rate

If osmolality is falling at a rate >8 mosmol/kg/hr, consider:
- Reducing the rate of IV fluids
- Reducing the rate of insulin infusion (if commenced)

At all times, if the patient is not improving, senior clinician advice must be sought.

OTHER CONSIDERATIONS
- Identify and treat the underlying precipitant - careful examination and screening for underlying causes, and regular monitoring and re-evaluation is necessary
- Consider underlying causes such as sepsis (including lower limb cellulitis, meningitis); silent ischaemia; and toxins (alcohol).
- If infection is present refer to the Therapeutic Guidelines or Statewide Medicines Formulary
- Commence prophylactic anticoagulation as the patient will have a high risk of venous thromboembolism.
- Assess foot risk score – assume high risk if the patient is obtunded or uncooperative:
  - Ensure heels are off-loaded
  - Ensure daily foot checks

ONGOING MANAGEMENT
- Convert patient to subcutaneous insulin when biochemically stable and the patient is ready and able to eat and drink.
- Transfer from IV insulin to subcutaneous insulin using 75% of the previous day's (24 hours) intravenous requirements. Prescribe on Subcutaneous Insulin Order and Blood Glucose Monitoring Chart SCGH MR 846
- The starting insulin can be a pre-mix analogue (e.g. NovoMix 30®) or basal insulin analogues (e.g. Lantus® or Levemir®)
- Patients with pre-existing insulin-treated Diabetes Mellitus should be re-started on their usual insulin regimen when clinically appropriate
- Contact the diabetes team for education and follow up at patient's discharge.
ACKNOWLEDGMENTS
FSH Adult Hyperosmolar Hyperglycaemic State FSH-END-GUI-0003

KEY RELATED DOCUMENTS
• Intravenous Therapy. SCGH Nursing Practice Guideline 4. Updated August 2016.
• Medicines Management. SCGH Hospital Policy 141. September 2017.
• Adult Diabetic Ketoacidosis (DKA) Guidelines and Management Record (MR 836), SCGH
• Adult Variable Rate Intravenous Insulin Guideline and Management Record MR826 SCGH
• Adult Hyperosmolar Hyperglycaemic State Guideline and Management Record (MR 383), SCGH
• SGLT2 inhibitors (gliflozins) and euglycaemic ketoacidosis guideline (draft)

KEY LEGISLATION, ACTS &
• MP 0077/18 Statewide Medicines Formulary January 2018
• OD 0647/16 WA National Standard for User-Applied Labelling of Injectable Medicines, Fluids and Lines, October 2016
• OD 0561/14 WA High Risk Medication Policy, September 2014
• Australian Commission on Safety and Quality in Healthcare. National terminology, abbreviations and symbols to be used in the prescribing and administering of medicines in Australian hospitals. 2008.

STANDARDS
NSQHs Standard:

MONITORING
Evaluation, audit and feedback processes will be reviewed to monitor outcomes.
• Use Clinical Incident Management Systems to review trends and investigate incidents as required

REFERENCES
3. The King Edward Memorial Hospital DKA in pregnancy clinical guideline.
4. The Royal Women’s Hospital - Melbourne DKA in pregnancy clinical guideline.

APPENDICES
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The hard copy of this document may be out of date. To ensure you are reading the current version, check the Drug Guidelines section of the Pharmacy Intranet site.
Appendix 1: Adult HHS Management Record

These guidelines are for the treatment of adults with Hyperosmolar Hyperglycaemic State (HHS), previously known as hyperosmolar non-ketotic coma (HONK), and are designed to allow both prescriptions and relevant observations to be recorded together (related guideline on the intranet HRM025).

The guideline should be adapted to the clinical situation where necessary. Seek advice from senior clinician, diabetes specialist, units in cases of uncertainty.

Continuous cardiac monitoring must be instituted when intravenous potassium chloride is administered at a rate of greater than 10mmol/hour (IVA Policy) for intravenous Potassium (44413).

This guideline should not be used:
- in children (<18 years) even if they have DKA, seek specialist advice. OR
- in the management of Diabetic ketoacidosis (DKA) see MR35

**ENTRY CRITERIA:** (Tick boxes if criteria present, if none re-consider diagnosis)

Does patient have characteristic features of:
- hyperviscosity
- marked hyperglycaemia (>30 mmol/L)
- increased serum/plasma osmolality (>320 mosmol/kg)
- [2][3][4][5][6] glucose-urea in mmol/L

**NEW PRINCIPLES OF MANAGEMENT OF HHS**

1. Correct hypovolaemia first using 0.9% sodium chloride solution for resuscitation. Do not use Hartmann’s or Isotonic.

2. Expect an initial rise in sodium level.

3. Close monitoring of electrolytes as high risk of abnormalities and cerebral oedema.

4. Treat Hyperglycaemia with intravenous fluids only. Only commence insulin when blood glucose is no longer falling.

5. Secondary risk prevention. (Assess foot risk score on admission)

**ESSENTIAL INITIAL RESULTS AND ASSESSMENT OF SEVERITY**

- Blood (capillary) ketones ______ mmol/L
- Blood glucose ______ mmol/L
- Venous bicarbonate ______ mmol/L
- Venous (or arterial) pH
- Potassium ______ mmol/L. Beware initial low potassium, if level <3.5 mmol/L call for senior medical advice immediately.
- Serum Osmolality ______ mosmol/kg
- Creatinine ______ mmol/L
- Systolic Blood pressure ______ mmHg
- GCS (Glasgow Coma Scale) _______