### Hyperosmolar Hyperglycaemic State (HHS) care pathway in adults

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<th>Theme</th>
<th>Time</th>
<th>Clinical assessment and monitoring</th>
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</table>
|       | 0-60 minutes | History/examination, NEWS, cardiac monitoring, urine output<br>Establish adequate intravenous lines (preferably 2 large bore IV cannules)<br>Discuss with outreach/ICU team early if there are markers of high severity (see Table 1 overleaf) | 1 litre over 1 hour<br>(caution in HF/CKD/BW <50 kg)<br>Aim for 2-3 litres positive balance by 6 hours | VTE prophylaxis (low molecular weight heparin) | Prevent harm<br>VTE prophylaxis (low molecular weight heparin)<br>Avoid using intravenous insulin infusions<br>Prevent hypoglycaemia<br>Glucose 5% or 10% at 125 ml/hr if BG is <4 mmol/L | Prevent harm<br>VTE prophylaxis (low molecular weight heparin)<br>Avoid using intravenous insulin infusions<br>Prevent hypoglycaemia<br>Glucose 5% or 10% at 125 ml/hr if BG is <4 mmol/L |}

#### Aims of therapy

1. Improvement in clinical status and replacement of all estimated fluid losses by 24 hours
2. Gradual decline in osmolality: drop of 3-8 mOsm/kg/hr
3. Blood glucose: aim to keep to 10-15 mmol/L in the first 24 hours
4. Avoid hypoglycaemia and hypokalaemia
5. Prevent harm: VTE, osmotic demyelination, fluid overload, foot ulceration

#### Criteria for resolution of HHS

1. Clinical and cognitive status is back to the pre-morbid state
2. Osmolarity <300 mOsm/kg
3. Hypovolaemia has been corrected (urine output ≥0.5 ml/kg/hr)
4. Blood glucose <15 mmol/L

#### Theme

<table>
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<tr>
<th>Clinical status / NEWS</th>
<th>Precipitating cause(s)</th>
<th>Osmolarity (VBG/blood)</th>
<th>Measure/calculate (2xNa(^+) + Glucose + Urea)</th>
<th>Aim for gradual decline of 3-8 mOsm/kg/hr</th>
<th>How to interpret osmolality results</th>
<th>Blood glucose (BG) (aim for 10-15 mmol/L in the first 24 hours)</th>
<th>Interventions</th>
<th>Assessments and prevention</th>
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<tbody>
<tr>
<td>History/examination, NEWS, cardiac monitoring, urine output&lt;br&gt;Establish adequate intravenous lines (preferably 2 large bore IV cannules)&lt;br&gt;Discuss with outreach/ICU team early if there are markers of high severity (see Table 1 overleaf)</td>
<td>Assess for precipitating cause(s): sepsis, diabetic foot infection, treatment omissions, vulnerable adult, vascular event (myocardial infarction, stroke)</td>
<td>Ongoing management of the precipitating cause(s)</td>
<td>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)</td>
<td>Check every hour for 6 hours</td>
<td>Check every hour</td>
<td>Check every hour (check Figure 1 overleaf for details)</td>
<td>Intravenous fluids (0.9% saline)&lt;br&gt;(In IV line 1): (caution in HF/CKD/BW &lt;50 kg)</td>
<td>Prevent harm&lt;br&gt;VTE prophylaxis (low molecular weight heparin)&lt;br&gt;Avoid using intravenous insulin infusions&lt;br&gt;Prevent hypoglycaemia&lt;br&gt;Glucose 5% or 10% at 125 ml/hr if BG is &lt;4 mmol/L</td>
</tr>
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#### Timeframe

- **0-60 minutes**
  - History/examination, NEWS, cardiac monitoring, urine output.<br>Establish adequate intravenous lines (preferably 2 large bore IV cannules).<br>Discuss with outreach/ICU team early if there are markers of high severity (see Table 1 overleaf).

- **60 minutes - 6 hours**
  - 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).

- **6-12 hours**
  - 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).

- **12-24 hours**
  - Check every 2 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).

- **24-72 hours**
  - Check every 4 hours (no clinical improvement then check every 2 hours)
  - Replacement of all estimated fluid losses by 24 hours
  - Individual BG target 6-10 mmol/L

#### Interventions

- **Intravenous fluids (0.9% saline)**
  - (In IV line 1): (caution in HF/CKD/BW <50 kg)
  - Aim for 2-3 litres positive balance by 6 hours

- **Insulin infusion**
  - (FRH 0.05 units/kg/hr using Actrapid*)
  - Only commence if positive fluid balance and BG plateaued on repeated measurements (2-3 occasions)

- **Glucose infusion**
  - 5% or 10% at 125 ml/hr (In IV line 2)
  - Only initiate if BG <14 mmol/L

- **Potassium**
  - Senior review / ICU outreach<br>Check Table 2 overleaf for potassium replacement guidelines

#### Assessments and prevention

- **Prevent harm**
  - VTE prophylaxis (low molecular weight heparin)<br>Avoid complications e.g. fluid overload, cerebral oedema, osmotic demyelination (deteriorating conscious level)

- **Prevent hypoglycaemia**
  - Glucose 5% or 10% at 125 ml/hr if BG is <4 mmol/L

- **Prevent foot ulceration**
  - Daily foot checks

- **Refer to the Inpatient diabetes team early.**

- **Escalate management if there is clinical deterioration.**

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**Abbreviations:**
Hyperosmolar Hyperglycaemic State (HHS) care pathway in adults

**Figure 1: Managing osmolality changes during treatment of HHS**

- **Calculated*/Measured Osmolality**
  - **Decreasing by <3 mOsm/kg/hour**
    - Sodium
    - Fluid status
    - Action: Increase rate of infusion of 0.9% saline
  - **Decreasing at appropriate level (3-8 mOsm/kg/hour)**
    - Sodium
    - Fluid status
    - Action: Continue same rate of fluids
  - **Decreasing >8 mOsm/kg/hour**
    - Sodium
    - Fluid status
    - Action: Consider reducing infusion rate of IV fluids and/or insulin (if already commenced)
  - **Increasing**
    - Sodium
    - Fluid status
    - Action: Increase rate of infusion of 0.9% saline
- **Negative fluid balance and no signs of fluid overload**
  - Sodium
  - Action: Consider switching to 0.45% saline at same rate
- **Adequate fluids balance**
  - Sodium

*Calculated osmolality (mOsm/kg) = (2xNa⁺) + Glucose + Urea

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

**Figure 2: Managing glucose changes during treatment of HHS**

- **Blood glucose**
  - Fall of blood glucose at a rate of up to 5 mmol/L per hour is ideal
  - Blood glucose falling <5 mmol/L per hour
  - Blood glucose falling >5 mmol/L per hour

**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**

<table>
<thead>
<tr>
<th>Potassium level in first 24 hours (mmol/L)</th>
<th>Potassium replacement in infusion solution</th>
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<tbody>
<tr>
<td>≥6.0</td>
<td>Senior review ICU/outreach</td>
</tr>
<tr>
<td>5.5-5.9</td>
<td>Nil</td>
</tr>
<tr>
<td>3.5-5.5</td>
<td>40 mmol/L</td>
</tr>
<tr>
<td>&lt;3.5</td>
<td>Senior review ICU/Outreach. Additional potassium is required</td>
</tr>
</tbody>
</table>