# Hyperosmolar Hyperglycaemic State (HHS) care pathway in adults

## Clinical features (all the below)
1. Marked hypovolaemia
2. Osmolarity ≥320 mOsm/kg
3. Marked hyperglycaemia (≥30 mmol/L)
4. Without significant ketonaemia (<3.0 mmol/L)
5. Without significant acidosis (pH ≥7.3) and bicarbonate ≥15 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: Holistic assessment of the following:
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

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## 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 canes
- Discuss with Outreach/ICU team early if there are markers of high severity (see Table 1 overleaf)

### Precipitating cause(s)
- Assess for precipitating cause(s): sepsis, diabetic foot infection, treatment omissions, vulnerable adult, vascular event (myocardial infarction, stroke)

### Osmolality (VBG/blood)
- Measure/calculate (2xNa⁺ + Glucose + Urea)
- Aim for gradual decline of 3-8 mOsm/kg/hr

### How to interpret osmolality results
- 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)

### Blood glucose (BG)
- Aim for 10-15 mmol/L in the first 24 hours
- Fall in BG should be up to 5.0 mmol/L per hour (check Figure 1 overleaf for details)

### Interventions

#### Intravenous fluids (0.9% saline)
- 1 litre over 1 hour (caution in HF/CVD/BW <50 kg)

#### Insulin infusion (FR80 0.05 units/kg/hr using Actrapid*)
- Use DNA guidelines if ketonaemia (>3.0 mmol/L) or ketonuria (>2+)
- Start FR80 if ketonaemia (>3.0 - 5.0 mmol/L) or ketonuria (>2+)
- Use DA guidelines if >5.0 mmol/L or ketonuria (>2+)
- Only commence if positive fluid balance and BG plateaued on repeated measurements (≥2 occasions)

#### Glucose infusion: 5% or 10% @ 125ml/hr
- Not required at this stage

#### Potassium
- Senior review / ICU outreach if potassium ≥3.5 or ≤4.0 mmol/L

### 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)

#### Prevent hypoglycaemia
- Glucose 5% or 10% at 125 ml/hr if BG ≤4.4 mmol/L

#### Prevent foot ulceration
- Daily foot checks

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**Abbreviations:**
- BG: blood glucose
- BW: body weight
- CVD: chronic kidney disease
- FR80: 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
- VRI=variable rate intravenous insulin infusion
- VTE=venous thromboembolism

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Figure 1: Managing osmolality changes during treatment of HHS

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

Figure 2: Managing glucose changes during treatment of HHS

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>
</tr>
</thead>
<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>

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.