# 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 ketonuria (<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

## 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 cannulae)
- 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 omission, vulnerable adult, vascular event (myocardial infarction, stroke)
- Ongoing management of the precipitating cause(s)

### Osomality (BVG/blood)
- Measure/calculate (ΣNa⁺ + 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

### How to interpret osmality results
- Check Figure 1 overleaf
- Check every hour

### 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 2 overleaf for details)

### Interventions

#### Intravenous fluids (0.9% saline)
- 1 litre over 1 hour (caution in HF/XCD/BW <50 kg)
- Aim for 2-3 litres positive balance by 6 hours
- Reassess fluid balance to plan fluids replacement for the next 12 hours

#### Insulin infusion (FR86 0.05 units/kg/hr using Actrapid*)
- Use DKA guidelines if ketonuria (>3.0 mmol/L) or ketonuria (≥2+)
- Only commence if positive fluid balance and BG plateaued on repeated measurements (≥2 occasions)
- Start FR86 if ketonuria (>1.0 - 2.0 mmol/L) or ketonuria (≥2+)
- Only initiate if 80 <14 mm mol/L
- Rate may need adjustment to 1 unit/hr to achieve BG target 10-15 mmol/L
- Continue infusion at 125 ml/hr

#### Glucose infusion: 5% or 10% @ 125ml/hr
- Not required at this stage
- Only initiate if 80 <14 mmol/L
- Continue infusion at 125 ml/hr

#### Potassium
- Senior review / ICU outreach
- Only initiate if 80 <14 mm mol/L
- Continue infusion at 125 ml/hr

### 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 <15 mmol/L

#### Prevent foot ulceration
- Daily foot checks

### Refer to the inpatient diabetes team early.
- Escalate management if there is clinical deterioration.

### Abbreviations:
- BG= blood glucose; BW=body weight; CKD=chronic kidney disease; FR86=fixed rate intravenous insulin infusion; HF=heart failure; h=hour; ICU=intensive care unit; IV=intravenous; kg=kilograms; NEWS=national early warning score; U&Es=urea and electrolytes; VBG=venous blood gas analysis; VFR=fixed rate intravenous insulin infusion; VTE=venous thromboembolism

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Figure 1: Managing osmolality changes during treatment of HHS

**Calculated*/Measured Osmolality**

- Decreasing by <3 mOsm/kg/hour
- Decreasing at appropriate level (3-8 mOsm/kg/hour)
- Decreasing >8 mOsm/kg/hour
- Increasing

**Negative fluid balance and no signs of fluid overload**
- Increase rate of infusion of 0.9% saline
- Continue same rate of fluids
- Consider reducing infusion rate of IV fluids and/or insulin (if already commenced)
- Increase rate of infusion of 0.9% saline
- Consider switching to 0.45% saline at same rate

**Adequate fluids balance**

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

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

**Negative fluid balance and no signs of fluid overload**
- Increase rate of infusion of 0.9% saline
- Commence Fixed Rate Insulin infusion (FRRI) 0.05 units/kg/hour OR increase rate to 0.1 units/kg/hour (if already commenced)
- Convert to variable rate intravenous insulin infusion (VRII) or sc insulin once HHS has resolved

**Adequate fluids balance**

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

<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>