

Hyperosmolar Hyperglycaemic State (HHS) care pathway in adults

Clinical features (all the below)	Aims of therapy	Criteria for resolution of HHS: Holistic assessment of the following:
1) Marked hypovolaemia	1) Improvement in clinical status and replacement of all estimated fluid losses by 24 hours	1) Clinical and cognitive status is back to the pre-morbid state
2) Osmolality ≥ 320 mOsm/kg	2) Gradual decline in osmolality: drop of 3-8 mOsm/kg/hr	2) Osmolality < 300 mOsm/kg
3) Marked hyperglycaemia (≥ 30 mmol/L)	3) Blood glucose: aim to keep to 10-15 mmol/L in the first 24 hours	3) Hypovolaemia has been corrected (urine output ≥ 0.5 ml/kg/hr)
4) Without significant ketonaemia (≤ 3.0 mmol/L)	4) Avoid hypoglycaemia and hypokalaemia	4) Blood glucose < 15 mmol/L
5) Without significant acidosis (pH ≥ 7.3) and bicarbonate ≥ 15 mmol/L	5) Prevent harm: VTE, osmotic demyelination, fluid overload, foot ulceration	

A mixed picture of HHS and DKA occurs relatively frequently

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 cannulas) Discuss with outreach/ICU team early if there are markers of high severity (see Table 1 overleaf)			Check for continuing improvement	Expect steady recovery, patient eating and drinking, and biochemistry as it was prior to HHS Ongoing management of the precipitating cause(s) Replacement of all estimated fluid losses by 24 hours Individual BG target 6-10 mmol/L
Precipitating cause(s)		Assess for precipitating cause(s): sepsis, diabetic foot infection, treatment omissions, vulnerable adult, vascular event (myocardial infarction, stroke)			Ongoing management of the precipitating cause(s)	
Osmolality (VBG/blood) Measure/calculate ($2 \times \text{Na}^+$) + 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 ($2 \times \text{Na}^+$ + glucose). Recalculate osmolality once urea is available, and then use ($2 \times \text{Na}^+$ + glucose + urea)		Check every 2 hours	Check every 4 hours (if no clinical improvement then check every 2 hours)	
How to interpret osmolality results		Check Figure 1 overleaf	Check Figure 1 overleaf	Check Figure 1 overleaf	Check Figure 1 overleaf	
Blood glucose (BG) (Aim for 10-15 mmol/L in the first 24 hours)		Check every hour Fall in BG should be up to 5.0 mmol/L per hour (check Figure 2 overleaf for details)		Check every hour (check Figure 2 overleaf for details)	Check every hour (check Figure 2 overleaf for details)	
Interventions						
Intravenous fluids (0.9% saline) (In IV line 1) (caution in HF/CKD/BW < 50 kg)		1 litre over 1 hour (caution in HF/CKD/BW < 50 kg)	Aim for 2-3 litres positive balance by 6 hours	Aim for up to 6 litres positive balance by 12 hours	Reassess fluid balance to plan fluids replacement for the next 12 hours	Can be stopped if patient is eating and drinking
Insulin infusion (FRIII 0.05 units/kg/hr using Actrapid®) (In IV line 2)		Use DKA guidelines if ketonaemia (> 3.0 mmol/L) or ketonuria ($\geq 2+$) Start FRIII if ketonaemia ($> 1.0 - \leq 3.0$ mmol/L) or ketonuria ($< 2+$)	Only commence if positive fluid balance and BG plateaued on repeated measurements (> 2 occasions)		Rate may need adjustment to 1 unit/hr to achieve BG target 10-15 mmol/L	VRIII if not eating and drinking Otherwise convert to subcutaneous insulin
Glucose infusion: 5% or 10% @ 125ml/hr (In IV line 2)		Not required at this stage	Only initiate if BG < 14 mmol/L		Continue infusion at 125 ml/hr	Can be stopped if patient is eating and drinking
Potassium		Senior review / ICU outreach if potassium < 3.5 or > 6.0 mmol/L	Check Table 2 overleaf for potassium replacement guidelines	Check Table 2 overleaf for potassium replacement guidelines	Check Table 2 overleaf for potassium replacement guidelines	Check U&Es daily
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)				VTE prophylaxis until discharge Daily foot checks
Prevent hypoglycaemia		Glucose 5% or 10% at 125 ml/hr if BG < 14 mmol/L				Target BG 6-10 mmol/L
Prevent foot ulceration		Daily foot checks				Daily foot checks
Refer to the inpatient diabetes team early. Escalate management if there is clinical deterioration.						Review by inpatient diabetes team before discharge

Abbreviations: BG=blood glucose; BW=body weight; CKD=chronic kidney disease; FRIII=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; VRIII=variable rate intravenous insulin infusion; VTE=venous thromboembolism

Figure 1: Managing osmolality changes during treatment of HHS

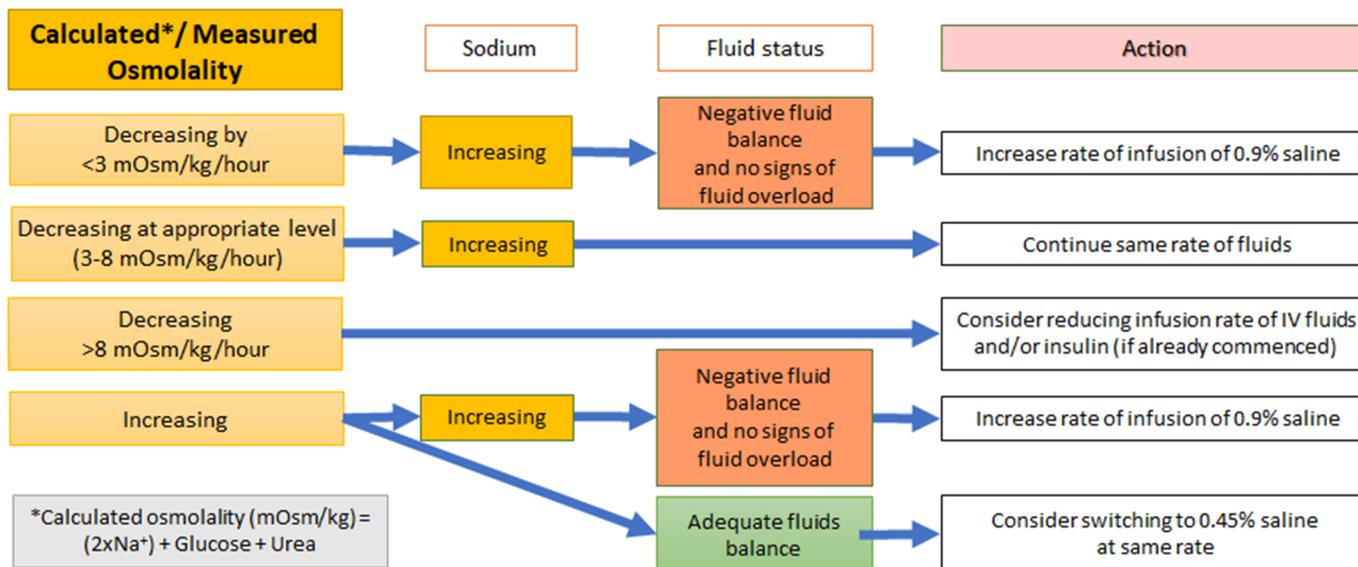
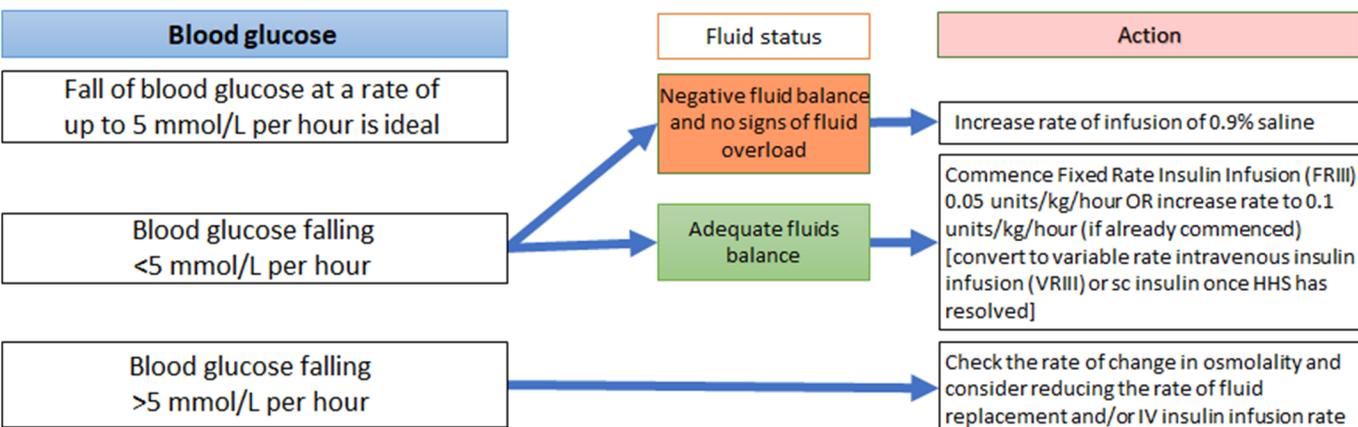


Figure 2: Managing glucose changes during treatment of HHS



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

Potassium level in first 24 hours (mmol/L)	Potassium replacement in infusion solution
≥6.0	Senior review ICU/outreach
5.5-5.9	Nil
3.5-5.5	40 mmol/L
<3.5	Senior review ICU/Outreach. Additional potassium is required