

Queensland Health

Management of Hyperglycaemic Hyperosmolar State in Adults ≥ 16 years

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Introduction

Hyperosmolar hyperglycaemia state (HHS) is a medical emergency. HHS is a clinical diagnosis based on biochemical as well as clinical features (e.g. dehydration), and may frequently present with neurological abnormalities (i.e., altered mental status). HHS is associated with significant morbidity and mortality and must be diagnosed promptly and managed intensively. Your local specialist diabetes/endocrinology team should be involved as soon as possible after presentation.

Diagnostic requirements

- Hyperglycaemia (BGL ≥ 30 mmol/L)
- Hyperosmolarity (measured or serum osmolality ≥ 320 mOsm/kg)
- Clinical features of dehydration / hypovolaemia
- Absence of significant ketosis (ketones ≤ 3 mmol/L)
- Absence of significant acidosis (pH ≥ 7.3 and bicarbonate ≥ 15 mmol/L).

* A mixed picture of HHS and DKA occurs relatively frequently.

Protocol use

This protocol is to be used for the management Hyperglycaemic Hyperosmolar State (HHS) in adults over the age of 16. This protocol is **NOT** to be used for the treatment of:

- Diabetic ketoacidosis (DKA) – use DKA management guidelines if ketones > 3 mmol/L
- Management of HHS or DKA in children.

Specialist management and discharge planning

Refer for specialist review at earliest opportunity upon diagnosis of HHS. Diabetes specialist review team should include:

- physician specialising in diabetes (e.g. endocrinologist or general physician depending on local health service referral pathways)
- diabetes educator
- dietitian.

Assessment of severity

Refer to HDU (or ICU depending on local services) for consultation if any of the following:

- Abnormal AVPU (Alert, Voice, Pain, Unresponsive) or GCS < 12
- Oxygen saturation $< 92\%$ on room air (assuming normal baseline respiratory function)
- Systolic blood pressure < 90 mmHg
- Hypothermia
- Measured serum sodium > 160 mmol/L
- Measured / calculated Osmolality > 350 mOsm/kg
- pH < 7.1
- Severe hypokalaemia (< 3 mmol/L) or hyperkalaemia (> 6 mmol/L) at admission
- Acute kidney injury (serum creatinine > 200 μ mol/L) and/or oliguria (< 0.5 mL/kg/hr)
- Major adverse cardiovascular event (e.g. myocardial infarction or stroke) *
- Pregnancy. *

* and consult with appropriate medical specialty team/s.

Management of Hyperglycaemic Hyperosmolar State in Adults ≥16 years			
Immediate Management ‘hour 1’	Early Management ‘hour 2–6’	Ongoing Management ‘hour 7–12’	Ongoing Management ‘hour 12–48’
STEP 1: Initial assessment - History and examination, including mental status, volume assessment, systemic examination and foot inspection - BGL and fingerprick ketones 2 x IV cannulae - FBE, CHEM20 - Blood cultures	STEP 1: Clinical assessment and monitoring - Hourly fluid balance (aim 2–3L positive balance by hour 6) - Hourly assessment of consciousness (AVPU) Osmolality: Measure or calculate osmolality hourly for first 6 hours (VBG and/or U+E, ensuring VBG at least at ‘hour 2’ and ‘hour 4’) - Until urea is available, use (2 x Na+) + glucose - If rapid urea monitoring is available, use (2 x Na+) + glucose + urea - Use a consistent formula for calculation - Aim: Drop of 3–8mOsm/kg/hr BGL: Measure hourly - Aim: Drop of up to 5mmol/L per hour and achieve and maintain range 10–15mmol/hr within first 24 hours Ketones: - If initial ketones >1, measure hourly until ketones <1, then 2-hourly - If initial ketones <1, measure 2-hourly	STEP 1: Clinical assessment and monitoring - Hourly fluid balance (aim 6L positive balance by hour 12) 2-hourly assessment of consciousness (AVPU) Osmolality: Measure or calculate 2-hourly - Use a consistent formula for calculation: (2 x Na+) + glucose OR (2 x Na+) + glucose + urea - Aim: Drop of 3–8mOsm/kg/hr If osmolality increasing: AND negative fluid balance + no signs of fluid overload: Increase rate of 0.9% saline AND adequate fluid balance: Consider switching to 0.45% saline at same rate BGL: Measure hourly - Aim: Drop of up to 5mmol/L per hour and achieve and maintain range 10–15mmol/hr within first 24 hours Ketones: - If ketones >1, measure hourly until ketones <1, then 2-hourly - If ketones <1, measure 2-hourly	STEP 1: Clinical assessment and monitoring - Continue fluid balance 4-hourly assessment of consciousness (AVPU) (if stable) - Ongoing management of precipitating cause(s) Osmolality: Measure or calculate 4-hourly If osmolality increasing: AND negative fluid balance + no signs of fluid overload: Increase rate of 0.9% saline AND adequate fluid balance: Consider switching to 0.45% saline at same rate BGL: Measure hourly until IV insulin ceased Ketones: Measure 4-hourly until HHS resolution (<i>refer to criteria below</i>)
STEP 2: Fluid replacement (cannula 1) 0.9% sodium chloride 1000mL/hr. Repeat if hypotensive (systolic BP <100 mmHg) <i>Caution if:</i> HF, advanced CKD or low BW (<50kg)	STEP 2: Fluid replacement (cannula 1) - Continue 0.9% sodium chloride: 500mL/hr for ‘hour 2–3’ 500mL/hr for ‘hour 4–5’ 250mL/hr for ‘hour 6–9’ - Adjust rates based on volume status, osmolality and rate of BGL decline <i>Caution if:</i> HF, advanced CKD or low body weight (<50kg)	STEP 2: Fluid replacement (cannula 1) - Continue 0.9% sodium chloride: 250mL/hr for ‘hour 6–9’ 250mL/hr for ‘hour 10–13’ - Adjust rates based on volume status, osmolality and rate of BGL decline (<i>see above</i>) - Encourage oral hydration if normal AVPU and clinically safe (e.g. no acute abdomen)	STEP 2: Fluid replacement - Continue 0.9% sodium chloride: 125mL/hr from hour 14 until patient is fluid replete and drinking/eating - Adjust rates based on volume status, osmolality and rate of BGL decline - Encourage oral hydration if normal AVPU and clinically safe
STEP 3: Potassium replacement (cannula 1) - If K+ <3.5mmol/L, replace K+ - If K+ 3.5–6mmol/L, no immediate action. Consider replacement if IV insulin to be commenced - If K+ >6mmol/L, seek senior advice, consider clinical situation, perform ECG and assess symptoms. Treat with insulin only if severe hyperkalaemia or symptomatic. Refer to Electrolyte disturbance guidelines	STEP 3: Potassium replacement (cannula 1 or 2) - If K+ <3.5mmol/L, give 2 x 10mmol/100mL and recheck - If K+ 3.5–4mmol/L, give 10mmol/100mL and recheck - If K+ 4–6mmol/L, no immediate action - If K+ >6mmol/L, seek senior advice, consider clinical situation, perform ECG and assess symptoms. Treat with insulin only if severe hyperkalaemia or symptomatic. Refer to Electrolyte disturbance guidelines	STEP 3: Potassium replacement (cannula 1 or 2) - If K+ <3.5mmol/L, give 2 x 10mmol/100mL over 2 hours and recheck - If K+ 3.5–5mmol/L, give 40mmol per 1L 0.9% sodium chloride at up to 250mL/hr - If K+ 5–6mmol/L, no immediate action - If K+ >6mmol/L, as per Early Management ‘hour 2–6’ (<i>column 2</i>)	STEP 3: Potassium replacement Continue K+ replacement as required
STEP 4: IV insulin (cannula 2) Do NOT commence insulin if: - Ketones <1, pH >7.3 and bicarb >15mmol/L Commence insulin only if: - DKA (ketones >3, pH <7.3, bicarb <15mmol/L) AND K+ >3.5mmol/L (<i>refer to DKA guidelines</i>) - Ketones 1–3 AND not acidotic (venous pH >7.3 and bicarb >15mmol/L AND K+ >3.5mmol/L, using FRII at 0.05U/kg/hr (Actrapid®)). If K+ <3.5mmol/L, replace K+ and recheck at 1-hour	STEP 4: IV insulin (cannula 2) Do NOT commence insulin if: - Ketones <1, pH >7.3 and bicarb >15mmol/L Commence insulin only if: - Positive fluid balance and BGL plateaued (on >2 occasions), using FRII at 0.05U/kg/hr (Actrapid®)	STEP 4: IV insulin and glucose (cannula 2) <i>If not on insulin:</i> Commence insulin once positive fluid balance and BGL plateaued (on >2 occasions), using FRII at 0.05U/kg/hr (Actrapid®) <i>If already on FRII:</i> Continue initial rate of insulin if BGLs are decreasing. Rate may need adjustment to achieve BGL drop of 5mmol/L per hour and target 10–15mmol/L - Once BGL <14mmol/L, change to VRII (weight-based) AND commence 5% glucose at 100mL/hr via “Y-SITE” (cannula 2) or slower if volume overload concerns. Continue IV glucose until insulin infusion is ceased	STEP 4: IV insulin and glucose <i>If not on insulin:</i> Commence insulin once positive fluid balance and BGL plateaued (on >2 occasions), using FRII at 0.05U/kg/hr (Actrapid®) <i>If on FRII:</i> Revise rate to achieve BGL aims as above. Once BGL <14mmol/L, change to VRII (weight-based) AND commence IV 5% glucose at 100mL/hr via “Y-SITE” (cannula 2) or slower if volume overload concerns <i>If on VRII:</i> Review orders 6–12-hourly to maintain BGL target 10–15mmol/L and prevent hypoglycaemia
STEP 5: Other actions - Assess degree of dehydration - Secondary screen, as indicated (e.g. b-HCG, serial troponins and ECG, septic screen [e.g. urine MCS, CXR, foot imaging], CT-head [suspected stroke]) - Commence fluid balance and neurological observations - Consider IDC insertion - VTE prophylaxis (all patients unless contraindicated) - Thiamine 300mg IV daily - Removal of insulin pump (if patient using) - Assess foot risk – if high risk, for heel protectors and daily foot checks - Review medications and withhold potentially hazardous medications (e.g. metformin)	STEP 5: Other actions - Assess for precipitating causes and treat/refer as appropriate - Ensure ‘Other actions’ from ‘hour 1’ (<i>column 1</i>) are completed		STEP 5: Transition to subcutaneous insulin - Give patient’s usual long-acting insulin (if applicable) - The patient is ready to transition to subcutaneous insulin when the following criteria are met: - Well and eating and drinking - Long-acting insulin has been given at least 2 hours prior to cessation of insulin infusion
STEP 6: Contact accepting consultant - Inpatient diabetes specialist team (following local referral guidelines) and/or contact ICU/HDU if referral criteria met - Accepting consultant – Dr:			Criteria for resolution of HHS: - BGL <15mmol/L - Osmolality <300mOsm/kg - Correction of volume losses - Clinical and cognitive status is back to pre-morbid state
Abbreviations: BGL = Blood Glucose Level BW = Body Weight CXR = Chest X-Ray VTE = Venous Thromboembolism (<i>NB: HHS also has high risk for arterial thrombosis</i>) FRII = Fixed Rate Insulin Infusion VRII = Variable Rate Insulin Infusion			

Key principles

Fluid replacement

IV sodium chloride

- Use IV 0.9% sodium chloride solution as principal fluid to restore circulating volume.
- Typical volume loss in HHS is 100–220 mL/kg (10–22 L for a 100 kg individual).
- Aims:
 - 1.1 Gradual and safe correction of volume losses and serum osmolality.
 - 1.2 Gradual decline in osmolality (3–8 mOsm/kg per hour) to reduce risk of neurological complications.
 - 1.3 Glucose should fall by no more than 5 mmol/L/hr.
 - 1.4 Ensure accurate fluid balance chart (and consider IDC insertion) until IV fluids no longer required.
 - 1.5 2–3 L positive balance by 6 hours and replace estimated loss within first 24 hours.
 - 1.6 More cautious rehydration is needed in the elderly, those with body weight <50 kg, or those with significant pre-existing heart or kidney disease.
 - 1.7 Minimum urine output (0.5 mL/kg/hr).
 - 1.8 Encourage oral hydration once it is safe to do so.
- An initial rise in sodium is expected due to the reversal of relative *pseudohyponatraemia* in the context of hyperglycaemia. The rate of change of serum sodium should not exceed 10 mmol/L in 24 hours. Only switch to 0.45% sodium chloride if **osmolality** is not declining despite adequate positive fluid balance.

IV glucose

- **Commence IV glucose infusion once BGL <14 mmol/L** (e.g. 10% glucose at 100 mL/hr) and continue concurrent sodium chloride for volume replacement, while needed.
- Note that if on fixed dose insulin infusion, the rate may need to be adjusted/amended to variable rate, pending BGL trend.

Potassium replacement

- Potassium depletion is common in HHS; however, potassium shifts are less pronounced than in DKA as individuals are less acidotic. Comorbidities and medications (e.g. acute or chronic kidney disease, diuretic use) will also influence serum potassium levels. Potassium replacement is therefore individualised.
- Seek senior review if K⁺ level <3.5 or >6 mmol/L.

All infusions containing potassium must be given via an infusion pump or burette

Maximum concentration = 40mmol/L peripherally to prevent phlebitis.

- Exception: isotonic, premixed potassium chloride 10mmol/100mL minibags (commercially premade, ready to use) can be given peripherally. Note: Minibags must be given via an infusion pump.

Maximum rate: - **With burette = 10mmol/hr**

- **With infusion pump = 20mmol/hr**

If maximum rates or concentration are exceeded, cardiac monitoring in a high acuity bed, as well as administration through a large vein with high blood flow (e.g. CVC, venous access port, PICC) is required. For further information on potassium replacement please refer to your local prescribing guidelines.

Insulin therapy

- Insulin therapy prior to adequate fluid replacement may cause cardiovascular collapse.
- Fixed rate IV insulin **should NOT be started** as part of initial treatment unless significant ketonaemia present (e.g. fingerprick ketones >1mmol/L).
- Timing of insulin infusion commencement:
 - 1.9 EARLY (within 'hour 1'): If ketonaemia (fingerprick ketones >3 mmol/L), venous pH <7.30 and bicarbonate <15mmol/L (i.e. mixed DKA/HHS) then follow **Statewide DKA guidelines at 0.1U/kg/hr.**
 - 1.10 EARLY (within 'hour 1'): if fingerprick ketones between 1– 3 mmol/L AND not acidotic (venous pH >7.30 and bicarbonate >15mmol/L then commence fixed rate insulin infusion at 0.05U/kg/hr early.
 - 1.11 Otherwise, commence insulin infusion ONLY once BGL has stopped falling following initial fluid resuscitation. Commence fixed rate insulin infusion at 0.05U/kg/hr.

Other aims to be considered at time of presentation

- Seek and treat underlying HHS precipitant/s.
 - 1.12 Usually, >65 years old with insidious onset.
 - 1.13 Common triggers: infection (urinary, respiratory), cardiovascular event (MI, stroke) or cessation of usual DM therapies, glucocorticoids, antipsychotics
- Prevention of complications: VTE, neurological, fluid overload, foot ulceration
 - 1.14 **Prophylactic low molecular weight heparin (LMWH)** unless contraindicated.
 - 1.14.1 Continue LWMH until discharge, considering extended treatment in those considered very high risk.
- **Frequent clinical review** for complications: fluid overload, neurological deterioration (cerebral oedema or osmotic demyelination syndrome).
- **Foot protection:**
 - 1.15 Initial foot assessment.
 - 1.16 Heel protectors and an appropriate mattress if: immobility, neuropathy, peripheral vascular disease, lower limb deformity or altered level of consciousness.
 - 1.17 Daily foot checks.
- Thiamine iv 300mg daily with ongoing treatment as clinically indicated.

Recovery phase (24–72 hours post-admission)

- Aim for steady recovery and ensure ongoing management of any precipitating cause/s and other acute issues.
- HHS resolution criteria:
 - 1.18 BGL <15 mmol/L
 - 1.19 Osmolality <300m Osm/kg
 - 1.20 Correction of volume losses
 - 1.21 Clinical and cognitive status is back to pre-morbid state.
- Convert to an appropriate subcutaneous insulin regimen once biochemically stable and eating and drinking.
- Assess for signs of fluid overload or cerebral oedema.
- Remove IDC once clinically appropriate.
- Encourage early mobilisation.
- Ensure involvement of inpatient specialist diabetes team.

References

- Joint British Diabetes Societies for Inpatient Care (JBDS-IP) Guidelines

[JBDS 06 The management of the hyperosmolar hyperglycaemic state \(HHS\) in adults with diabetes | The Association of British Clinical Diabetologists \(abcd.care\)](#)

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Document custodian

If you have any questions or feedback about this document, please contact the Queensland Diabetes Clinical Network Coordinator at QLDDiabetesNetwork@health.qld.gov.au.

Version control

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1.0	31 July 2025	Final version published.
2.0	30 September 2026	Insulin prescribing instructions updated.

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An electronic version of this document is available at <https://www.health.qld.gov.au/clinical-practice/guidelines-procedures/clinical-resources/diabetes-resources-for-health-professionals/diabetes-in-adults>

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This guideline is intended as a guide and provided for information purposes only. The information has been prepared using a multidisciplinary approach with reference to the best information and evidence available at the time of preparation. No assurance is given that the information is entirely complete, current, or accurate in every respect. The guideline is not a substitute for clinical judgement, knowledge and expertise, or medical advice. Variation from the guideline, taking into account individual circumstances, may be appropriate. This guideline does not address all elements of standard practice and accepts that individual clinicians are responsible for:

- Providing care within the context of locally available resources, expertise, and scope of practice
- Supporting consumer rights and informed decision making, including the right to decline intervention or ongoing management
- Advising consumers of their choices in an environment that is culturally appropriate, and which enables comfortable and confidential discussion. This includes the use of interpreter services where necessary
- Ensuring informed consent is obtained prior to delivering care
- Meeting all legislative requirements and professional standards
- Applying standard precautions, and additional precautions as necessary, when delivering care
- Documenting all care in accordance with mandatory and local requirements

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