1. Introduction

1.1. This document sets out the University Hospitals of Leicester (UHL) guidelines for the management of Hyperosmolar Hyperglycaemic State (HHS) in adults (previously known as Hyperosmolar Non-Ketotic Diabetic state (HONK)). It is based on the Joint British Societies (JBDS) guideline ‘The Management of the hyperosmolar hyperglycaemic state (HHS) in adults with Diabetes published in August 2012.

1.2. Hyperosmolar hyperglycaemic state (HHS) has no precise definition, but characteristic features that differentiate it from other hyperglycaemic states such as Diabetic ketoacidosis (DKA) are:
- Hypovolaemia
- Marked hyperglycaemia (30mmol/L or more) without significant hyperketonaemia (< 3mmol/L), ketonuria (2+ or less) or acidosis (pH>7.3, bicarbonate> 15mmol/L)
- Osmolality usually 320mosmol/kg or more

N.B. A mixed picture of HHS and DKA may occur. Metabolic acidosis may be present in patients who are critically unwell.

1.3 The Goals of the treatment of HHS are to treat the underlying cause and to gradually and safely:
- Normalise the osmolality
- Replace fluid and electrolyte losses
- Normalise blood glucose

Other goals include prevention of:
- Arterial or venous thrombosis
- Other potential complications e.g. cerebral oedema/central pontine myelinolysis
- Foot ulceration

1.4. HHS can be a complex condition to manage and is associated with a significant mortality. Diagnosis must be made promptly, treatment intensively monitored and the specialist diabetes team involved as soon as possible after admission.

1.5. Caution: in patients with Type 2 diabetes taking the class of oral hypoglycaemic agents “SGLT-2 inhibitors”. A risk of euglycaemic DKA has been identified with the use of ‘SGLT-2 inhibitors’. If any patient is on an SGLT-2 inhibitor (eg, dapagliflozin, canagliflozin, empagliflozin or combination products, Xigdou, Vokanamet, Synjardy) and is unwell please consider DKA, rather than HHS even if blood glucose level is not significantly elevated. For criteria for diagnosis of DKA refer to UHL Guideline for the Management of Diabetic Ketoacidosis in Adults (http://insitetogether.xuhl-tr.nhs.uk/pag/pagdocuments/Diabetic%20Ketoacidosis%20(DKA)%20in%20Adults%20UHL%20Guideline.pdf)
2. **Scope**

This guideline applies to all adult inpatients with Type 2 Diabetes and to all healthcare professionals who are responsible for the clinical management and/or care of these patients.

Usually HHS will be diagnosed and managed initially within the Emergency Department and LRI Acute Care Bay (ACB)/Acute Medical Unit. However, occasionally patients develop HHS whilst in hospital and this could occur in any ward area within UHL. Were this to occur please assess patient, initiate immediate treatment and discuss with medical SpR on-call regarding provision of care and on-going management.

3. **Recommendation, Standards and Procedural Statements**

3.1 **Definitions**

3.1.1 *Hyperosmolar hyperglycaemic state (HHS)* has no precise definition, but characteristic features that differentiate it from other hyperglycaemic states such as Diabetic ketoacidosis (DKA) are:

- Hypovolaemia
- Marked hyperglycaemia (30mmol/L or more) **without** significant hyperketonaemia (<3mmol/L), ketonuria (2+ or less) or acidosis (pH>7.3, bicarbonate>15mmol/L)
- Osmolality usually 320mosmol/kg or more

N.B. A mixed picture of HHS and DKA may occur. Metabolic acidosis may be present in patients who are critically unwell.

3.1.2 **Resolution of HHS occurs** when there is complete normalisation of electrolytes and osmolality, this may take up to 72 hours.

3.2 **Establishing the diagnosis of HHS**

3.2.1 Suspect HHS in unwell patients with blood sugars > 30mmol (for anyone with known Type 2 diabetes or previously unknown to have diabetes) and all 3 of the following are present:

- High blood sugars without significant ketonaemia (blood ketones <3mmol/L or ketonuria < 2+) or acidosis (pH>7.3)
- High Osmolality > 320mosmol/kg
- Hypovolaemia

**Calculated Serum osmolality = 2Na⁺ + glucose + urea: (normal range 280-295mosmol/kg)**

If Type 1 diabetes or hyperglycaemia with acidosis (pH <7.3 or bicarbonate<15) AND ketones present (blood ketones>3mmol/L or ketonuria >2)

Or

Euglycaemic DKA, which has been identified with use of SGLT-2 inhibitors (see section 1.5) **THEN FOLLOW UHL DIABETIC KETOACIDOSIS (DKA) PROTOCOL**

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Hyperosmolar Hyperglycaemic State (HHS) in Adults UHL Guideline
V2 approved by Policy and Guideline Committee on 29 November 2019 Trust Ref: B10/2018.

Next review: December 2022
3.2.2 The presence of one or more of the following may indicate severe HHS and need for admission to HDU/Level 2 environment.

**IMMEDIATE** senior review and consideration of admission to HDU/ITU should be considered if one or more of following present:

- Osmolality >350mosmol/kg
- Pulse <60 OR >100 bpm
- Serum sodium >160mmol/L
- SaO2<92% on air (assuming normal baseline)
- Venous or arterial pH<7.1
- Decompensated heart or renal disease
- Hypokalaemia (<3.5mmol/L) on admission
- Hypothermia
- GCS< 12 (or abnormal AVPU score)
- Macrovascular event such as acute MI or CVA
- Systolic BP<90 mmHg
- Other serious Co-morbidity

3.3 Special considerations

3.3.1 Serious complications may arise during the management of HHS as a result of treatment. These include:

- Hypo or hyperkalaemia
- Hypoglycaemia
- Cerebral oedema
- Pulmonary Oedema
- Central pontine myelinolysis

3.3.2 It is critical that the patient and treatment are regularly monitored and reviewed as per guidelines in order to minimise the risk of these complications

3.3.3 Groups of patients, in whom extra caution is required in their care and management particularly regarding fluid balance include:

- Elderly (>70yrs)
- Cardiac or renal failure
- Other serious co-morbidities

3.4 Provision of care for patients with HHS

3.4.1 Adult patients with suspected HHS admitted to the LRI Emergency Department (ED) should have the diagnosis confirmed and their treatment initiated in ED. Patients should then be transferred to the Acute Care Bay (ACB) LRI, or if clinically indicated,
to ITU. If patients require stepdown from ACB to a medical ward this should be to the diabetes ward only (unless clinical condition suggests alternative ward is more appropriate and this should be discussed and documented by either Diabetes SpR, Diabetes specialist in-reach team or medical SpR on-call).

3.4.2 If a patient with HHS is admitted to ED or ACB then the SpR or Consultant should be informed and the patient should be reviewed by a senior member of the admitting team immediately, if the NEWS indicates (see 3.2.2), or directly after clerking and initiation of treatment by a junior member of the team if NEWS does not indicate immediate senior review.

3.4.3 Patients who develop HHS in other LRI ward areas should have their treatment initiated according to this guideline by the ward team, they should be reviewed by the Diabetes SpR or Medical SpR on-call as soon as possible and transfer to ACB should be arranged. If HHS develops in a patient on a Diabetes ward (LRI) then an assessment can be made by the Diabetes SpR regarding whether the patient requires transfer to the ACB or whether treatment can be managed by the Diabetes ward team.

3.4.4 If HHS develops in a ward area at GGH or LGH then treatment should be initiated by the ward team and the patient should then be reviewed by the Diabetes SpR or Medical SpR on-call (depending on availability at each site) and a decision made regarding the appropriate area for the patient to be managed. In normal working hours (Mon-Fri, 9-5pm) there is a Diabetes SpR available to discuss cases (contact via switchboard).

3.4.5 If HHS develops outside of the ED or ACB then once immediate treatment has been initiated by the ward team referral for senior review (Diabetes SpR or Medical SpR on-call) should be made within the first hour of establishing diagnosis and initiating treatment.

3.5 HHS Care Pathway
The following table details the HHS Care pathway divided into timed sections.
This pathway should be followed once a diagnosis of HHS has been established (see section 3.2)

<table>
<thead>
<tr>
<th>Section A</th>
<th>Immediate management 0-60 minutes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Section B</td>
<td>60 minutes to 6 hours</td>
</tr>
<tr>
<td>Section C</td>
<td>6-12 hours</td>
</tr>
<tr>
<td>Section D</td>
<td>12-24 hours</td>
</tr>
<tr>
<td>Section E</td>
<td>24 hours to Day 3</td>
</tr>
</tbody>
</table>

HHS Care Pathway

Section A (0-60 mins)

Aims
Time = 0 mins at time intravenous (IV) fluids are commenced. If access problems, involve critical care support immediately
• Commence IV 0.9% sodium chloride – 1 litre over 1 hour  
  o Consider more rapid replacement if SBP below 90 mmHg  
  o Caution in the elderly where too rapid rehydration may precipitate heart failure but insufficient may fail to reverse acute kidney injury
• Only commence insulin infusion (0.05 units/kg/hr) IF there is significant ketonaemia (3β-hydroxybutyrate (blood ketone level) greater than 1 mmol/L) or ketonuria 2+ or more (i.e., mixed DKA and HHS picture)
• Establish appropriate monitoring of patient (hourly capillary blood glucose, Na+, K+, urea and calculated osmolality)
• Perform clinical and biochemical assessment of patient
• Review IV fluid regimen based on patient’s clinical and biochemical assessment, blood glucose levels and calculated osmolality

### Action 1 – intravenous (IV) access and initial investigation and management

- Assess Airway, Breathing, Circulation and NEWS
- Site Large bore IV cannula
- Commence fluid replacement (for regimen see Action 2 below)
- Clinical assessment (RR, Temp, BP, Pulse, O2 SATS, NEWS score, GCS, full clinical examination including feet (assume high risk if patient obtunded or uncooperative) and mental state assessment
- Assess degree of dehydration, insert urinary catheter to monitor hourly urine output and calculate fluid balance
- Examine for source of sepsis or evidence of vascular event
- Initial investigations (capillary blood glucose (CBG), venous plasma BG, U&E, Measured or calculated osmolality, venous blood gas, blood ketones, FBC, ECG, CXR, urine dip and if indicated MSU for culture)
- Blood cultures if clinically indicated
- Establish monitoring regime appropriate to patient, generally hourly for first 6 hours  
  o Chart osmolality/glucose/sodium on HHS prescription chart  
  o Continuous pulse oximetry  
  o Continuous cardiac monitoring
- Commence prophylactic LMWH
- Consider IV antibiotics if sepsis identified or suspected
- Ensure heels are off-loaded
- Ensure early senior review and/or inform specialist diabetes team
- Confirm usual medication for diabetes and perform pregnancy test if appropriate

### HHS Care pathway

#### Action 2 – restoration of circulating volume and potassium replacement

If Systolic BP < 90mmHG Consider more rapid replacement of 0.9% sodium chloride. A slower infusion rate should be considered in elderly patients (>70yrs) and those with renal/ cardiac failure (CVP may be considered in such groups).

When systolic BP > 90mmHg follow regimen in the table below if appropriate for patient.
Assessment of fluid balance, aiming to achieve positive fluid balance of 2-3L by 6 hours, should be part of the on-going management in all patients.

Maintain potassium within normal range as follows:

**POTASSIUM REPLACEMENT PRESCRIPTION ADVICE (use cardiac monitor)**

<table>
<thead>
<tr>
<th>Serum potassium concentration</th>
<th>Replacement advice</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; 5.5mmol/L</td>
<td>No indication to replace</td>
</tr>
<tr>
<td>&lt; 5.5mmol/L</td>
<td>Use 20mmol in 500mL ‘premixed’ bag</td>
</tr>
</tbody>
</table>

**Note:** fluid regime below is a guide only and should be amended according to patient's clinical status, osmolality and fluid balance. Review regularly and use clinical judgement.

<table>
<thead>
<tr>
<th>Fluid</th>
<th>Volume over time</th>
<th>Rate (ml/hr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st Litre</td>
<td>0.9% sodium chloride</td>
<td>1000ml over 1 hour</td>
</tr>
<tr>
<td>2nd Litre</td>
<td>0.9% sodium chloride +/- potassium</td>
<td>1000ml over 1 hour</td>
</tr>
<tr>
<td>3rd Litre</td>
<td>0.9% sodium chloride +/- potassium</td>
<td>1000ml over 4 hour</td>
</tr>
<tr>
<td>4th Litre</td>
<td>0.9% sodium chloride +/- potassium</td>
<td>1000ml over 4 hour</td>
</tr>
<tr>
<td>5th Litre</td>
<td>0.9% sodium chloride or 0.45% sodium chloride +/- potassium</td>
<td>1000ml over 6 hour</td>
</tr>
<tr>
<td>6th Litre</td>
<td>0.9% sodium chloride or 0.45% sodium chloride +/- potassium</td>
<td>1000ml over 6 hour</td>
</tr>
</tbody>
</table>

Avoid hypoglycaemia

If capillary blood glucose falls to <14mmol/L then commence 10% glucose at 62.5ml/hr in addition to ongoing fluid replacement. Aim to keep capillary blood sugar between 10-15mmol/L in first 24hrs and avoid hypoglycaemia.

Regular review of patient and clinical parameters is critical.

**HHS Care pathway**

**Action 3 Insulin therapy**

- Commence at presentation ONLY if significant ketonaemia (blood ketone >1mmol/L or ketonuria >2+)
- Commence IV insulin if blood glucose level falling at rate < 5 mmol/L/hr despite adequate fluid replacement (see Action 2)
- Use IV human soluble insulin infusion (50 units in 50ml) at 0.05 units/kg/hr (e.g Actrapid or Humulin S)
- Modify IV insulin infusion rate as indicated (see Table below)
- If known to have diabetes and on treatment, review and withhold whilst on IV insulin
- Aim to keep blood glucose level 10-15mmol/L in first 24 hours

If CBG falls to < 14 mmol/L commence 10% glucose at 62.5ml/hr in addition to on-going fluid replacement

<table>
<thead>
<tr>
<th>Weight (kg)</th>
<th>IV insulin rate in unit/hour (based on 0.05unit/kg/hr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature (°C)</td>
<td>Insulin Dose (units/hr)</td>
</tr>
<tr>
<td>-----------------</td>
<td>-------------------------</td>
</tr>
<tr>
<td>55</td>
<td>2.75</td>
</tr>
<tr>
<td>60</td>
<td>3</td>
</tr>
<tr>
<td>65</td>
<td>3.25</td>
</tr>
<tr>
<td>70</td>
<td>3.5</td>
</tr>
<tr>
<td>75</td>
<td>3.75</td>
</tr>
<tr>
<td>80</td>
<td>4</td>
</tr>
<tr>
<td>85</td>
<td>4.25</td>
</tr>
<tr>
<td>90</td>
<td>4.5</td>
</tr>
</tbody>
</table>

**Action 4 – senior review**

It is most important that patients with HHS are reviewed by medical a SpR/consultant immediately if NEWS indicates (see 3.2.2) or once immediate management has been initiated, if initially seen by a junior member of the team.

It is the role of the junior medical team and nursing staff to request a senior medical review in patients who develop HHS outside ED or ACB, the ward team should refer to the on-call SpR for Medicine or Diabetes SpR (depending on availability) within 1 hour of diagnosing HHS and initiating immediate treatment.

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**HHS Care Pathway**

**Section B (60mins-6 hours)**

**Aims**
- To achieve gradual decline in osmolality (3-8 mosmol/kg/hr)
- To maintain potassium in normal range
- To avoid hypoglycaemia, aim to keep blood glucose 10-15 mmol/L in first 24 hrs
- Monitor vital signs and chart Medical Early Warning Score (NEWS)
- Maintain accurate fluid balance chart (minimum urine output 0.5ml/kg/hr)
- Ensure that senior review by SpR or Consultant has been undertaken

**Action 1 – reassess the patient and monitor**
- Review hourly initially, to ensure adequate progress in reducing osmolality and glucose levels is being made
- Ensure regular vital signs and NEWS charting and review
- Ensure accurate fluid balance charting (minimum urine output 0.5ml/kg/hr)

**Action 2 – review metabolic parameters**
- Measure glucose, urea and electrolytes hourly and calculate osmolality \((2Na^+ + \text{glucose} + \text{urea})\) and record on HHS prescription chart.
  - If plasma \(Na^+\) increasing but osmolality declining at appropriate rate, continue 0.9% sodium chloride
  - If plasma \(Na^+\) increasing AND osmolality increasing (or declining at less than 3 mosmol/kg/hr) check fluid balance. If positive balance is inadequate increase rate of infusion of 0.9% sodium chloride
If osmolality increasing and fluid balance is adequate, consider switching to 0.45% sodium chloride at the same rate

- If osmolality falling at rate exceeding 8 mosmol/kg/hr consider reducing infusion rate of IV fluids and/or insulin (if already commenced)

- If blood glucose falling less than 5mmol/L check fluid balance
  - If positive balance is inadequate, increase rate of infusion of 0.9% sodium chloride
  - If positive fluid balance is adequate, commence low dose IV insulin (0.05 units/kg/hr) or if already running, increase rate to 0.1 units/kg/hr

- Maintain potassium in normal range

- Hypokalaemia (less than 3.5 mmol/L) and hyperkalaemia (greater than 6 mmol/L) are life threatening conditions and warrant senior review. They are less common in HHS than DKA but monitoring and replacement are essential

<table>
<thead>
<tr>
<th>Potassium level in first 24 hr (mmol/L)</th>
<th>Potassium replacement in infusion solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Over 5.5</td>
<td>Nil</td>
</tr>
<tr>
<td>3.5-5-5</td>
<td>20mmol in 500mL pre-mixed bag</td>
</tr>
<tr>
<td>Below 3.5</td>
<td>Senior review as additional potassium required</td>
</tr>
</tbody>
</table>

- Aim to keep blood glucose 10-15mmol/L in first 24 hours
  - If blood glucose falls below 14mmol/L commence 10% glucose at 62.5ml/hr AND CONTINUE 0.9% sodium chloride solution

**HHS Care pathway**

**Section C (6-12 hours)**

**Aims**

- Ensure that clinical and biochemical parameters are improving
- Continue IV fluid replacement to achieve positive balance of 3-6 litres by 12 hours
- Assess for and avoid complications of treatment (fluid overload, cerebral oedema, extra pontine myelinolysis)
- Continue to treat precipitating causes
- Avoid hypoglycaemia

**Action 1 – reassess the patient and monitor vital signs**

- If not improving as desired (see section B), seek senior advice and contact on-call Diabetes SpR, if within working hours. If out of hours contact the on-call SpR for Medicine
- Ensure electronic referral (via ICE) is made to diabetes team – see Appendix B

**Action 2 – review biochemical and metabolic parameters**

- Continue charting blood glucose hourly; sodium and calculated osmolality 2 hourly
  - Take appropriate action (as outlined in Section B above)
- Maintain an accurate fluid balance chart
- Avoid hypoglycaemia
  - Aim to keep blood glucose 10-15mmol/L in first 24 hours
  - If blood glucose falls below 14 mmol/L commence 10% glucose at 62.5ml/hr AND
CONTINUE 0.9% sodium chloride solution

Section D (12-24 hours)

Aims

- Ensure continuing improvement of clinical and biochemical parameters
- Continue IV fluid replacement to achieve remaining replacement of estimated fluid losses within next 12 hours.
- Continue IV insulin with or without 10% glucose solution to maintain blood glucose 10-15mmol/L
- Assess for complications of treatment (fluid overload, cerebral oedema, extra pontine myelinolysis)
- Continue to treat precipitating causes

Action 1 – reassess the patient and monitor vital signs

- If not improving as desired (see section B), seek senior advice and contact on-call Diabetes SpR, if within working hours. If out of hours contact the on-call SpR for Medicine
- Ensure electronic referral (via ICE) is made to diabetes team – see Appendix B

Action 2 – review biochemical and metabolic parameters

- Continue charting blood glucose hourly on prescription chart; sodium and calculated osmolality 4 hourly if improvement maintained (if not continue 2 hourly)
  - Take appropriate action (as outlined in Section B above) depending on results
  - Do not expect biochemistry to have normalised by 24 hrs (sodium and osmolality are likely to be raised)
  - Maintain an accurate fluid balance chart, plotting osmolality and make appropriate adjustments to fluid replacement rates
- Adjust insulin infusion rate hourly by 1 unit/hr increments or decrements to achieve desired CBG

HHS Care Pathway

Section E 24 hours to day 3

Expectation: patient should be steadily recovering, beginning to eat and drink, biochemistry returning to normal

- Ensure that clinical and biochemical parameters are improving or have normalised
  - Continue IV fluids until eating and drinking normally
  - Switch to variable rate insulin if not eating and drinking when biochemically stable
  - Convert to appropriate subcutaneous insulin regime (Appendix A) if eating and drinking when biochemically stable
  - Encourage early mobilisation
  - Daily urea and electrolytes
  - Remove catheter when clinically appropriate
- Assess for signs of fluid overload or cerebral oedema
- Assess for evidence of continuing sepsis, review antibiotic prescription daily
- Daily foot checks
- Continue LMWH until day of discharge (consider extended treatment in very high risk patients)
- Ensure patient has been reviewed by a member of the diabetes team
• Convert to appropriate subcutaneous regime when biochemically stable
  o For those newly diagnosed with type 2 diabetes or new to insulin treatment, this should be managed by the diabetes team, but if not available (out of hours or at weekend) see Appendix A.
  o For patients who have previously been on s/c insulin see guidance in Appendix A

### After care

- Most patients should go home on subcutaneous insulin
- For patients with previously undiagnosed diabetes or well controlled on oral agents, switching from insulin to the appropriate oral hypoglycaemic agent should be considered after a period of stability (weeks or months)
- Ensure patient has appropriate diabetes education prior to discharge and arrange follow-up by diabetes team

3.6. There are key recommendations/principles that are included in the JBDS Management of HHS Guidelines 2012 that differ from historic HONK guidance, these include:

  a) Measuring or calculating osmolality (2Na⁺ + glucose + urea) frequently to monitor the response to treatment.
  b) Using (IV) 0.9% sodium chloride solution as the principle fluid to restore circulating volume and reverse dehydration. Only switching to 0.45% sodium chloride solution if the osmolality is not declining despite adequate positive fluid balance. An initial rise in sodium is expected and is not itself an indication for hypotonic fluids. Thereafter, rate of fall of plasma sodium should not exceed 10 mmol/L in 24 hours
  c) The fall in blood glucose should be no more than 5 mmol/L/hr. Low dose IV insulin (0.05 units/kg/hr) should be commenced once the blood glucose is no longer falling with IV fluids alone OR immediately if there is significant ketonaemia (3β-hydroxybutyrate (blood ketone level) greater than 1 mmol/L).
  d) Assess foot risk on admission

4. **Education and Training**

4.1 It is expected that all registered staff working in the Emergency Department (ED), LRI admissions Acute Care Bay (ACB) and Diabetes Wards (LRI) have a responsibility to understand the management of HHS and up-date their knowledge. They will be supported by the Diabetes Team but staff would be expected to have undertaken Insulin Safety training (accessed via HELM) and familiarised themselves with this guidance.

4.2 All clinical staff working in any location within UHL would be expected to seek senior advice if they were presented with a patient with HHS and they did not feel adequately trained to manage the clinical case.

5. **Monitoring and Audit Criteria**

Outcome measures will be to benchmark the incidence of HHS against equivalent national and regional data for admissions. To assess adherence to the guidelines, outcome measures and effectiveness, audit will be performed periodically. The audit will be undertaken by the Diabetes Team.
Data relating to the use of intravenous insulin will be audited on a yearly basis as part of the national Diabetes Inpatient Audit. This data is submitted centrally, analysed and fed back to the Trust.

Monitoring and audit will be led by the Chair of the Diabetes Inpatient Safety Committee.

<table>
<thead>
<tr>
<th>What will be measured to monitor compliance</th>
<th>How will compliance be monitored</th>
<th>Monitoring Lead</th>
<th>Frequency</th>
<th>Reporting arrangements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Audit of HHS admissions retrospectively to be undertaken one year after implementation</td>
<td>Against agreed standards taken from this guidance.</td>
<td>Dr Kath Higgins</td>
<td>Initially after one year then 2 yearly thereafter</td>
<td>Diabetes inpatient safety committee</td>
</tr>
</tbody>
</table>

6. **Supporting References**

1. Joint British Societies (JBDS) guideline ‘The management of the hyperosmolar hyperglycaemic state (HHS) in adult with Diabetes’ published in August 2012

2. **UHL guidelines for:**
   - Prevention of Foot Complications and Management of Foot Ulcers in Patients with Diabetes – care plan (available on the UHL intranet as document 56006)
   - Adult Anticoagulation, Thrombosis and Thromboprophylaxis Policy (available on the UHL intranet as document 25866)

7. **Key Words**

   Hyperosmolar Hyperglycaemic State
   HHS
   HONK
   Diabetes
   Type 2

**CONTACT AND REVIEW DETAILS**

<table>
<thead>
<tr>
<th>Guideline Lead (Fiona Adlam) Advanced Specialist pharmacist Diabetes Dr Kath Higgins Head of service Diabetes and Endocrinology</th>
<th>Executive Lead Andrew Furlong</th>
</tr>
</thead>
</table>

Hyperosmolar Hyperglycaemic State (HHS) in Adults UHL Guideline
V2 approved by Policy and Guideline Committee on 29 November 2019 Trust Ref: B10/2018. Next review: December 2022
Details of Changes made during review:
June 2019 – changes to 3.4.1 with respect to step down after ACB
Changes to education 4.1 re HELM learning
Appendix A

Conversion to subcutaneous insulin

Where possible the conversion to subcutaneous insulin should be managed by the specialist diabetes team, especially for those with newly diagnosed type 2 diabetes (see point 4 below). Where this is not possible the following points give some guidance:

1. Restarting subcutaneous insulin for patients on an established insulin regimen

Previous regimen should be restarted

There should be a 30-60 min overlap between administration of the subcutaneous dose (of mixed insulin or mealtime ‘bolus’ insulin) and discontinuation of iv insulin infusion. This is because the half-life of iv insulin is only 3-4 mins and subcutaneous insulin may take considerably longer to be absorbed.

So the chain of events is:
- HHS resolved
- Patient starts eating and drinking
- Restart subcutaneous insulin (see below for timings)
- Stop IV insulin 30-60mins after s/c insulin

1.1 Patients on Basal Bolus regimen

Long acting or intermediate acting (aka NPH) insulin should have been stopped as per guideline recommendation

Do not stop IV insulin until some form of background/long acting insulin has been given.

For example if basal insulin is usually given at bed-time but you wish to restart subcutaneous insulin in morning, give ½ basal dose at breakfast with usual rapid acting insulin. Stop iv insulin infusion 30 mins later and continue with usual insulin regimen (e.g. normal meal time doses of rapid acting insulin plus the next full dose of long acting insulin may be given as usual).

1.2. Patients on twice daily mixed insulin

Re-introduce subcutaneous insulin before breakfast or evening meal and discontinue iv insulin infusion 30 mins after subcutaneous dose given.

2. Newly diagnosed type 2 diabetes

Do not stop IV insulin until some form of background insulin has been given.

Begin with Human NPH (Intermediate) insulin, such as Insuman Basal or Humulin I.

Calculate dose as 0.5 units per kg/ day and give ½ this dose morning and evening.

E.g For a 60kg patient the total dose is 30 units daily.
Prescribe Insuman Basal 15 units BD.

Please ensure a referral to the Diabetes Nurse specialist is made, although this should not delay the commencement of s/c insulin. (Appendix B)
Referral guidelines for the Diabetes Specialist Team

- Electronic referrals to Diabetes Specialist Nurses are made via ICE (patient will be seen within one working day of receiving referral, as long as this falls within normal working hours).

- The Diabetes Specialist Nurses may also be contacted via the ‘Diabetes Nurse Helpline’ on x4919.

- Referral to the on-call Diabetes SpR may be made via the LRI switchboard. Both available Mon-Fri (9am-5pm). **There is no out of hour’s diabetes on-call team.**
### ADULT HYPEROSMOLAR HYPERGLYCAEMIC STATE (HHS) PRESCRIPTION CHART

**University Hospitals of Leicester NHS Trust**

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**1) INTRAVENOUS FLUIDS** should be commenced via a large IV cannula (green or grey). If there is a problem with intravenous access critical care support should be requested immediately. Be aware of any fluids that may have already been given in the ambulance or ED.

<table>
<thead>
<tr>
<th>Sodium chloride</th>
<th>Rate mL/hour (circle as appropriate)</th>
<th>Prescriber</th>
<th>Administered by</th>
<th>2nd Nurse check</th>
<th>Time &amp; date commenced</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1st Litre over 1hr</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sodium chloride 0.9% 500ml/30mins</td>
<td>1000/other *</td>
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<tr>
<td>Sodium chloride 0.9% 500ml/30mins</td>
<td>1000/other</td>
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</tbody>
</table>

**Note:** Rate depends on clinical assessment of dehydration/risk of precipitating heart failure and fluid balance (target is to achieve positive fluid balance of 2-3L by 6 hours). Review regularly and use clinical judgement, seek senior advice if unsure.

**STANDARD INFUSION RATE; AMEND ACCORDING TO PATIENT FLUID STATUS**

<table>
<thead>
<tr>
<th>Sodium chloride</th>
<th>Rate mL/hour (circle as appropriate)</th>
<th>Potassium Check potassium &amp; correct as appropriate</th>
<th>Prescriber</th>
<th>Administered by</th>
<th>2nd Nurse check</th>
<th>Time &amp; date commenced</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>2nd Litre over 1hr</strong></td>
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<tr>
<td>Sodium chloride 0.9% 500ml/30mins</td>
<td>1000/other</td>
<td>Nil/20mmol in 500ml other</td>
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<tr>
<td>Sodium chloride 0.9% 500ml/30mins</td>
<td>1000/other</td>
<td>Nil/20mmol in 500ml other</td>
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</tbody>
</table>

**3rd Litre over 4hrs**

<table>
<thead>
<tr>
<th>Sodium chloride</th>
<th>Rate mL/hour (circle as appropriate)</th>
<th>Potassium Check potassium &amp; correct as appropriate</th>
<th>Prescriber</th>
<th>Administered by</th>
<th>2nd Nurse check</th>
<th>Time &amp; date commenced</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium chloride 0.9% 500ml/2hrs</td>
<td>250/other</td>
<td>Nil/20mmol in 500ml other</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sodium chloride 0.9% 500ml/2hrs</td>
<td>250/other</td>
<td>Nil/20mmol in 500ml other</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**4th Litre over 4hrs**

<table>
<thead>
<tr>
<th>Sodium chloride</th>
<th>Rate mL/hour (circle as appropriate)</th>
<th>Potassium Check potassium &amp; correct as appropriate</th>
<th>Prescriber</th>
<th>Administered by</th>
<th>2nd Nurse check</th>
<th>Time &amp; date commenced</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium chloride 0.9% 500ml/2hrs</td>
<td>250/other</td>
<td>Nil/20mmol in 500ml other</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sodium chloride 0.9% 500ml/2hrs</td>
<td>250/other</td>
<td>Nil/20mmol in 500ml other</td>
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</tbody>
</table>

**5th Litre over 4hrs**

<table>
<thead>
<tr>
<th>Sodium chloride</th>
<th>Rate mL/hour (circle as appropriate)</th>
<th>Potassium Check potassium &amp; correct as appropriate</th>
<th>Prescriber</th>
<th>Administered by</th>
<th>2nd Nurse check</th>
<th>Time &amp; date commenced</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium chloride 0.9% 500ml/2hrs</td>
<td>250/other</td>
<td>Nil/20mmol in 500ml other</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sodium chloride 0.9% 500ml/2hrs</td>
<td>250/other</td>
<td>Nil/20mmol in 500ml other</td>
<td></td>
<td></td>
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<td></td>
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</tbody>
</table>

**Notes:**

- **2nd Nurse check**
- **Time & date commenced**

**2) POTASSIUM PRESCRIPTION ADVICE** (use cardiac monitor)

<table>
<thead>
<tr>
<th>Potassium level in first 24 hours</th>
<th>Potassium replacement in mmol / 500mL of infusion solution</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Over 5.5mmol/L</td>
<td>Nil</td>
<td></td>
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<tr>
<td>3.5 to 5.5mmol/L</td>
<td>use 20mmol in 500mL ‘premixed’ bag</td>
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<tr>
<td>Less than 3.5mmol/L</td>
<td>Senior review</td>
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</tbody>
</table>

**3) INSULIN THERAPY** (Human soluble insulin e.g. Human Actrapid or Humulin S)

Commence at presentation ONLY if significant ketonaemia (blood ketones >1mmol/L or ketonuria >2+) or acidosis (pH <7.3). Commence IV insulin if capillary blood glucose (CBG) falling at rate < 5 mmol/L/hr despite adequate fluid replacement see below. Start IV soluble insulin infusion via a pump, containing 50 units soluble insulin in 50ml 0.9% sodium chloride at a continuous rate of 0.05 units/kg/hr. If known to have diabetes and is on anti-diabetic treatment (including insulin), withhold whilst on IV insulin. Monitor CBG, serum osmolality and serum sodium and adjust rate as per guidance above. Aim to keep CBG 10-15mmol/L in first 24 hours. If CBG falls < 14 mmol/L commence 10% glucose at 62.5ml/hr.

**INSULIN**

<table>
<thead>
<tr>
<th>Initial rate mL/hr 0.05 units/kg/hr</th>
<th>Prescriber</th>
<th>Administered by</th>
<th>2nd Nurse check</th>
<th>Time &amp; date commenced</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soluble Insulin 50 units in 50mL Sodium chloride 0.9%</td>
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<tr>
<td>Soluble Insulin 50 units in 50mL Sodium chloride 0.9%</td>
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<tr>
<td>Soluble Insulin 50 units in 50mL Sodium chloride 0.9%</td>
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</tbody>
</table>

**Notes:**

- **Prescriber**
- **Administered by**
- **2nd Nurse check**
- **Time & date commenced**

**Adapted from chart used at Countess of Chester Hospital NHS Foundation Trust**

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**Establish Diagnosis of HHS**

- High blood sugars > 30mmol/L without significant ketonaemia (blood ketones <3mmol/L or ketonuria <2+) or acidosis (pH<7.3)
- High Osmolality > 320mosmol/kg (calculated serum osmolality = 2Na+ + glucose + urea)
- Hypovolaemia

If Type 1 diabetes or hyperglycaemia with acidosis (pH <7.3 or bicarbonate<15) AND ketones present (blood ketones>2mmol/L or ketonuria >2+)

**Follow Diabetic Ketoacidosis (DKA) Protocol**

For more information refer to UHL guidelines on HHS management. Abridged version available on page 2 of this chart. Monitoring chart on page 3.

**Consultant**

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**Date** ………………………. **Ward** ………………………. **Patient’s weight (kg)** ………………………. **Addressograph**

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**Patient’s addressograph**

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**University Hospitals of Leicester NHS Trust**

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**Adapted from chart used at Countess of Chester Hospital NHS Foundation Trust**
Abridged ADULT HYPEROSMOLAR HYPERGLYCAEMIC STATE (HHS) MANAGEMENT GUIDELINES

Obtain IV access and commence fluid replacement immediately
If unable or poor IV access request critical care support immediately
Commence 0.9% sodium chloride – give 1 litre over 1 hour, consider more rapidly if systolic BP <90mm Hg (with caution in elderly)
Catheterise within first 60 mins to monitor fluid – aim minimum urine output 0.5ml/kg/hr

60 mins - 6 hours
Aim to achieve a gradual decline in osmolality of 3-8 mosmol/kg/hr
• Using 0.9% sodium chloride sodium chloride aim to give a further 0.5-1 L/hr depending on clinical assessment
Targets:
• A positive fluid balance of 2-3 litres by 6 hours
• A positive fluid balance of 3-6 litres by 12 hours
• Replacement of estimated fluid losses by 24 hour
Provided osmolality declining appropriately, continue 0.9% sodium chloride (even if serum sodium increasing)

ADJUST RATES AS FOLLOWS:
If osmolality increasing (or falling at rate <3mosmol/kg/hr) and serum sodium increasing, check fluid balance
• If inadequate increase rate of 0.9% sodium chloride
• If adequate consider changing to 0.45% sodium chloride infused at same rate
If osmolality falling at rate >8mosmol/kg/hr, consider,
• Reducing rate of IV fluids
• Reducing rate of insulin infusion (if commenced)
If Blood glucose falling by < 5 mmol/L/hr, check fluid balance
• If inadequate increase rate of infusion of 0.9% sodium chloride
• If adequate commence low dose IV soluble insulin (0.05 units/kg/hr) or if already running, increase rate to 0.1 units/kg/hr
Continue IV fluids until eating and drinking normally
Maintain potassium within normal range

Monitoring
• Baseline investigations: capillary and venous CBG, capillary/urinary ketones, measured osmolality, venous blood gas, FBC, U+E, blood cultures, ECG, CXR, urinalysis and culture
• Establish a regime appropriate to patient
• Check Na+, K+, Urea, CBG and calculated osmolality every hour for first 6 hours then every 2 hours if response satisfactory
• Monitor vital signs and chart early Warning Score (EWS). Document accurate fluid balance chart
• The rate of fall of plasma Na+ should not exceed 10mmol in 24 hours
• Use 24 hour HHS monitoring chart on page 3
• Assess for complications of treatment

Other measures
• Commence VTE prophylaxis (alternative if low eGFR) – follow trust protocol
• Consider IV antibiotics if sepsis identified or suspected – follow trust protocols
• Assess foot risk – assume high risk if uncooperative. Off load heels and ensure daily foot checks
• Assess mental state at baseline
• If known to have diabetes and is on anti-diabetic treatment (including insulin), withhold whilst on IV insulin

Expect patient to be steadily improving; complete normalisation of electrolytes and osmolality may take up to 72 hours
**ADULT HYPEROSMOLAR HYPERGLYCAEMIC STATE (HHS) MONITORING CHART**

**Patient’s addressograph**

Ward .................................................................

Consultant ..........................................................

*Calculated Serum osmolality = 2Na⁺ + glucose + urea: (normal range 280-295mosmol/kg)*

<table>
<thead>
<tr>
<th>Date</th>
<th>Biochemistry</th>
<th>IV Fluids (mL/hr)</th>
<th>Fluid Balance</th>
<th>Insulin (units/hr)</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>0.9% NaCl</td>
<td>0.45% NaCl</td>
<td>5% Glucose</td>
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<tr>
<td>Time</td>
<td>Hour Na K CBG Urea *Osmolarity</td>
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