Whittington Health NHS

Hyperglycaemic Hyperosmolar State – HHS

Subject:	Hyperglycaemic Hyperosmolar State
Policy Number	N/A
Ratified By:	Clinical Guidelines Committee
Date Ratified:	August 2005, Reviewed Aug 2007, Oct 2011 and November 2015
Version:	4.0
Policy Executive Owner:	Clinical Director, Medicine, Frailty and n
Designation of Author:	Consultant in Diabetes and Endocrinology
Name of Assurance Committee:	As above
Date Issued:	November 2015
Review Date:	November 2018
Target Audience:	Admitting medical staff
Key Words:	Hyperosmolar, Non-ketotic hyperglycaemia, K+ (potassium)

Version Control Sheet

Version	Date	Author	Status	Comment
1.0	Aug 2005	Dr M Rossi (Cons)	Off line	New guideline approved at CGC
2.0	Aug 20017	As above	Off line	Reviewed. No change required
3.0	Oct 2011	As above	Off line	Reviewed: Minor amendment section 3 'Potassium supplements' and insert of dosing table under section 4. Anticoagulation
4.0	Oct Nov 2015	As above	Live	Reviewed and updated in line with current national guidance. Changes agreed at Departmental level. Full consultation undertaken. Changes highlighted to CGC Chair, Nov 2015: 1. Change in definition of HHS encompassing a grp of characteristic features including serum osmolality > 320 (previous guideline advised >350). 2. Change in calculation of serum osmolality of 2Na+ + glucose + urea from 2(Na+ + K+) + glucose + urea. 3. Early use of IV insulin only if significant ketonaemia or lack of fall in glucose when adequate fluid hydration given. 4. Use of prohylactic heparin rather than full anti-coagulation. 5. Emphasizing need for daily foot checks.

➢ Criteria for use

A precise definition of HHS does not exist and is inappropriate but the characteristic features that differentiate it from Diabetic Ketoacidosis (DKA) are:

- Hypovolaemia
- Marked hyperglycaemia, blood glucose usually 30 -70 mmol/l
- High serum osmolality (>320mosmol/kg)
- No significant hyperketonaemia (<3 mmol/L)
- No significant acidosis (bicarbonate > 15 mmol/l or pH > 7.3 – acidosis can occur due to lactic acidosis or renal impairment)

NB a mixed picture of HHS and DKA may occur

Serum osmolality = $2Na^+$ + glucose + urea

➢ Important

This is a more sinister complication than diabetic ketoacidosis (DKA) with a higher mortality, as high as 20%.

Whilst DKA presents in hours, HHS comes on over many days and the dehydration and metabolic disturbances may be extreme. It may be complicated by vascular complications eg MI, stroke or arterial thrombosis.

Aim for slow shifts in serum blood glucose and rehydration to avoid cerebral oedema and central pontine myelinosis. Fluid losses in HHS are estimated to be between 100-220 ml/kg (6-13 litres in a person weighing 60 kg and 10-22 litres in a person weighing 100 kg, see Appendix 1). Cautious fluid replacement is required in those with co-morbidities. Too rapid replacement can result in heart failure and too slow will fail to treat acute kidney injury.

Please also see Whittington Health Trust Guideline:
'Diabetic Ketoacidosis (DKA)'

➢ Investigations

Urgent:

- Capillary blood glucose
- Venous blood glucose

- Urea & electrolytes
- Measured or calculated osmolality
- Venous blood gas
- Blood ketones and lactate
- FBC
- CRP
- Chest x-ray (CXR)
- Electrocardiogram (ECG)

Consider:

- Blood cultures
- Mid stream urine test for microscopy, culture & sensitivity
- Amylase
- Troponin T

Assess Severity:

The presence of one or more of the following indicates the need for immediate senior review with consideration of admission to HDU/ITU:

- osmolality >350 mosmol/kg
- sodium >160 mmo/L
- venous/arterial pH <7.1
- Potassium <3.5 mmol/L or >6 mmol/L
- GCS <12
- systolic BP (SBP) <90 mmHg
- serum creatinine >200 µmol/L
- urine output less than 0.5 ml/kg/hr
- macrovascular event eg MI, CVA or other serious co-morbidity

➢ Management

The goals of 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. Time 0min to 60min

- Commence IV 0.9% saline 1L over 1 hr (consider more rapid if SBP <90 mmHg or more slowly if elderly with heart failure)

- Monitor carefully and DO NOT give insulin unless blood glucose stops falling while giving intravenous fluids (in the absence of ketonaemia)

- Only commence insulin infusion **(fixed rate 0.05 units/kg/hr)** if there is significant ketonaemia (>1 mmol/L) or ketonuria 2+ (ie mixed DKA and HHS presentation)

- Clinically assess patient for:

    - Degree of dehydration
    - History of sepsis of vascular event
    - Mental state assessment
    - Foot examination and foot care (high risk of ulceration)

- Establish monitoring regimen (see Appendix 2) – will need 2-hourly venous blood gas to measure glucose, Na^+, K^+ and calculated osmolality

- Commence prophylactic low molecular weight heparin as per hospital guideline

- Consider IV antibiotics if sepsis identified or suspected

- Ensure early senior review

2. Time 60min to 6 hours

- To achieve a gradual decline in osmolality (3-8 mosmol/kg/hr):

    - Using 0.9% normal saline aim to give a further 0.5 – 1 L/hr depending on clinical assessment of dehydration / risk of precipitating heart failure and fluid balance **(target is to achieve positive fluid balance of 2-3 L by 6 hours)**

    - measure glucose hourly and venous blood gas 2-hourly and calculate osmolality ($2Na^+$ + glucose + urea):

        - If plasma Na+ increasing but osmolality declining at appropriate rate, continue 0.9% N/Saline (An initial rise in Na^+ is expected and in itself not an indication for hypotonic saline, see Appendix 1)

        - If plasma Na^+ increasing **AND** osmolality increasing (or declining at less than 3 mosmol/kg/hr) check fluid balance. If positive balance inadequate, increase rate of infusion of 0.9% sodium chloride

- If osmolality increasing and fluid balance adequate, consider switching to 0.45% sodium chloride at 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)

o The target for safe fall of blood glucose is 4 – 6 mmol/l/hour. If blood glucose falling less than 4 mmol/L per hour, check fluid balance:

- If positive balance inadequate, increase rate of infusion of 0.9% sodium chloride

- If positive fluid balance adequate, commence low dose IV insulin (0.05 units/kg/hr) or if already running, increase rate to 0.1 units/kg/hr

- To maintain potassium in the normal range:

KCl must be added to each bag of fluid depending on plasma K^+ level:

Plasma K^+	**KCl added to each litre**
<3.5	40 mmol + consider increased infusion rate
3.5 – 5.5	40 mmol
>5.5	nil

Stop KCl if patient anuric but continue IV Fluids

Discuss with senior if K+<3.5 as may need additional treatment

- Avoidance of hypoglycaemia:

o Aim to keep blood glucose 10-15 mmol/L in first 24 hours. If blood glucose falls below 14 mmol/L commence 5% or 10% glucose at 125 ml/hr **AND CONTINUE** 0.9% sodium chloride solution

- Maintain accurate fluid balance chart (minimum urine output 0.5 ml/kg/hr)

- Inform Diabetes Specialist Team - Diabetes SpR (bleep 3086 or 3106) or Diabetes Consultants (via switchboard)

3. Time 6 to 12 hours

The aim within this time period is to:

• Ensure that clinical and biochemical parameters are improving
o Continue charting capillary blood glucose hourly; venous blood gas for sodium, K^+ and calculated osmolality 2-hourly
o Take appropriate action (as outlined in time 60 minutes to 6 hour above)

• Continue IV fluid replacement to achieve positive balance of 3-6 litres by 12 hours maintaining an accurate fluid balance chart

• Assess for complications of treatment e.g. fluid overload, cerebral oedema, central pontine myelinolysis (e.g. deteriorating conscious level)

• Continue treatment of any underlying precipitant

• Avoid hypoglycaemia
  - o Aim to keep blood glucose 10-15 mmol/L in first 24 hours
  - o If blood glucose falls below 14 mmol/L commence 5% or 10% glucose at 125 ml/hr **AND CONTINUE** 0.9% sodium chloride solution

- If patient not improving ensure early senior review

4. Time 12 to 24 hours

The aim within this time period is to:

• Ensure continuing improvement of clinical and biochemical parameters:
  - o Continue charting blood glucose hourly; sodium and calculated osmolality can be reduced to 4 hourly if improving
  - o Do not expect biochemistry to have normalised by 24 hrs
  - o Take appropriate action (as outlined in time 60 minutes to 6 hour above depending on results

• Continue IV fluid replacement to achieve estimated fluid losses within the next 12 hours, and continue maintaining an accurate fluid balance chart

• Continue IV insulin with or without 5% or 10% glucose to maintain blood glucose 10-15 mmol/L

  - o **Adjust insulin infusion rate hourly by 1unit/hr increments or decrements to achieve desired CBG**

• Continue treatment of any underlying precipitant

- If patient not improving ensure early senior review

4. Time 24 hours to 3 days

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

• Ensure clinical and biochemical parameters are improving or have normalised:
  - o Continue IV fluids until eating and drinking normally
  - o **Initiate variable rate insulin if not eating and drinking normally**
  - o Convert to appropriate treatment (oral anti diabetic agents with or without subcutaneous insulin) when biochemically stable
  - o Encourage early mobilisation

- Daily urea & electrolytes

- Assess for signs of fluid overload or cerebral oedema
- Daily foot checks
- Ensure patient has been reviewed by Diabetes Team

➢ Contacts

- Diabetes SpR (bleep 3086 or 3106)
- Diabetes Specialist Nurse (bleep 2706)
- Consultant on-call via switchboard

➢ References

Joint British Diabetes Societies Inpatient Care Grp – The management of the hyperosmolar hyperglycaemic state (HHS) in adults August 2012

Appendix 1 –

Typical fluid & electrolyte losses in HHS

Hyperglycaemia results in an osmotic diuresis and renal losses of water in excess of sodium and potassium. Thus in managing HHS there is a requirement to correctly identify and address both dehydration and extracellular volume depletion, depending upon the degree of free water and sodium deficit as assessed in any individual case. Fluid losses in HHS are estimated to be between 100-220 ml/kg (10-22 litres in a person weighing 100 kg)

		For 60kg patient	**For 100kg patient**
Water	100-220 m//kg	6-13 L	10-22 L
Na+	5-13 mmol/kg	300-780 mmol	500-1300 mmol
Cl-	5-15 mmol/kg	300-900 mmol	500-1500 mmol
K+	4-6 mmol/kg	240-360 mmol	400-600 mmol

The aim of treatment should be to replace approximately 50% of estimated fluid loss within the first 12 hours and the remainder in the following 12 hours though this will in part be determined by the initial severity, degree of renal impairment and co-morbidities such as heart failure, which may limit the speed of correction.

Fluid replacement alone (without insulin) will lower blood glucose, which will reduce osmolality causing a shift of water into the intracellular space. This inevitably results in a rise in serum sodium (**a fall in blood glucose of 5.5 mmol/L will result in a 2.4 mmol/L rise in sodium**). This is not necessarily an indication to give hypotonic solutions.

A target blood glucose of between 10 and 15 mmol/L is a reasonable goal. Complete normalisation of electrolytes and osmolality may take up to 72 hours.

Remember - Isotonic 0.9% sodium chloride solution is already relatively hypotonic compared to the serum in someone with HHS.

Appendix 2

HHS Flowchart

To be printed out and completed during admission. Keep in Observation Folder then file in notes on discharge.

Name

Hospital Number

Date of Birth

Date

Measure CBG hourly. NB if bedside meters registers 'HI' or '>20' venous blood must be sent to laboratory for analysis or measured via Blood Gas Analyser

Calculated serum osmolality = $2Na^{+}$ + glucose + urea

Hour post admission:	**00**	**01**	**02**	**04**	**06**	**08**	**10**	**12**	**14**	**18**	**24**
Na+											
K^{+}											
Urea											
Calculated osmolality											
Plasma glucose or CBG											

Time insulin infusion started:

Appendix A

Plan for Dissemination and implementation plan of new Procedural Documents

To be completed and attached to any document which guides practice when submitted to the appropriate committee for consideration and approval.

Acknowledgement: University Hospitals of Leicester NHS Trust

Title of document:	**Hyperglycaemic Hyperosmolar State – HHS (Previously Termed HONK)**		
Date finalised:	**Re-issued November 2015**	**Dissemination lead: Print name and contact details**	**Dr M Rossi** **Consultant Diabetologist**
Previous document already being used?	**Yes** **(Please delete as appropriate)**		
If yes, in what format and where?	**On intranet**		
Proposed action to retrieve out-of-date copies of the document:	**IM&T retrieval of old document and replacement with new**		
To be disseminated to:	**How will it be disseminated/implemented, who will do it and when?**	**Paper or Electronic**	**Comments**
Clinical staff	**Via intranet**	**E**	
Medical clinicians	**Via email**	**E**	**Dr Rossi to action**
Is a training programme required?	**No**		
Who is responsible for the training programme?	**N/A**		

Appendix B

Equality Impact Assessment Tool

To be completed and attached to any procedural document when submitted to the appropriate committee for consideration and approval.

Impact (= relevance) 1 Low 2 Medium 3 High	Evidence for impact assessment (monitoring, statistics, consultation, research, etc	Evidential gaps (what info do you need but don't have)	Action to take to fill evidential gap	Other issues
Race	**1**			
Disability	**1**			
Gender	**1**			
Age	**1**			
Sexual Orientation	**1**			
Religion and belief	**1**			

Once the initial screening has been completed, a full assessment is only required if:

- The impact is potentially discriminatory under equality or anti-discrimination legislation
- Any of the key equality groups are identified as being potentially disadvantaged or negatively impacted by the policy or service
- The impact is assessed to be of high significance.

If you have identified a potential discriminatory impact of this procedural document, please refer it to relevant Head of Department, together with any suggestions as to the action required to avoid/reduce this impact.