JBDS GUIDANCE ON MANAGEMENT OF HYPEROSMOLAR HYPERGLYCAEMIC STATE (HHS) IN ADULTS

DIAGNOSIS: Based on characteristic features of

1. Hypovolaemia
+
2. Marked Hyperglycaemia (>30 mmol/L) [without significant ketonaemia or acidosis]
+
3. Osmolality (>320 mosmol/kg)

Patients may present with a mixed picture of DKA and HHS.
Lactic acidosis may occur if sepsis or patient on metformin with marked renal failure.

If Type 1 diabetes or hyperglycaemia with
Acidosis (pH < 7.3; HCO3 <15) AND
Ketones (Capillary ketones >3 mmol/L Urine dipstix ++/+++) **THEN FOLLOW DKA PROTOCOL**

TREATMENT GOALS

Normalise osmolality **gradually and safely** by
- Replacing fluid and electrolyte losses
- Normalising blood glucose (BG)

Prevent potential complications e.g. cerebral oedema

Treat underlying cause
Prevent arterial or venous thrombosis
Prevent foot ulceration

PRINCIPLES OF MANAGEMENT

1. **Measure or calculate osmolality frequently to monitor progress.** Use the following equation:-
   Osmolality = [2Na⁺+glucose+urea]
   Use point of care testing (ie blood gas analysers) for frequent monitoring after baseline samples.
   Venous samples will suffice if measurement of oxygen saturation not required.
2. **Assess severity of dehydration and use 0.9% saline (+/- K⁺) for fluid replacement WITHOUT insulin. This alone will lower BG which will reduce osmolality.**
   Monitor input/output. Aim to achieve positive fluid balance of 3-6 litres within first 12 hours and 100% of estimated fluid losses by 24 hours. Rate of replacement will be affected by individual degree of severity, renal function and co-morbidities. Typically fluid losses estimated to be approximately 110 – 220 ml/kg (i.e. 10-22 L for 100kg).
3. **Monitor and chart BG, osmolality and sodium** every 1-2 hr. An initial increase in sodium is expected and not an indication for hypotonic fluids. Use 0.45% saline only if osmolality not falling despite adequate fluids.
4. **Start low dose IV insulin (0.05 units/kg/hr) only** if significant ketonaemia (3-OH Butyrate >1 mmol/L) or ketonuria (>2+) at presentation OR if BG falling at rate of less than 5 mmol/hr despite adequate fluid replacement. Aim to maintain BG levels between 10 – 15 mmol/L for first 24 hours.
5. **Assess for complications of therapy (fluid overload, cerebral oedema, etc.) frequently.**
6. **Commence prophylactic anticoagulation.**
7. **Identify underlying precipitants (eg sepsis) and treat accordingly.**
8. **All of these patients at high risk of foot ulceration. Protect heels and perform daily foot checks.**

SEEK SENIOR ADVICE AT EARLIEST OPPORTUNITY AND IF NOT IMPROVING

ASSESSMENT OF SEVERITY

Consider admission to HDU / Level 2 environment if one or more of the following are present:-

- Osmolality>350 mosmol/kg
- Na > 160 mmol/L
- pH < 7.1
- K↓ or ↑on admission
- GCS < 12 or abnormal AVPU score
- O_2 sats < 92% on air
- BP <90 mmHg
- Pulse <60 or >100 bpm
- Urine output less than 0.5 ml/kg/hr
- CV event such as MI or CVA
- Hypothermia
- Other serious co-morbidity

HHS MONITORING CHART

NAME DOB / / HOSPITAL NO. WEIGHT

DATE / /							IV Fluids (ml/hr)						
Time	Hour	Na mmol/L	K mmol/L	BG mmol/L	Urea mmol/L	Osmolality mosmol/kg	0.9% Saline	0.45% Saline	5% Glucose	10% Glucose	Urine Output	Fluid Balance	Insulin units/hr
	1												
	2												
	3												
	4												
	5												
	6												
	7												
	8												
	9												
	10												
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	24												

Recommend check Na, K, Urea, BG and calculated osmolality every hour for first 6 hours then every 2 hours if response satisfactory

FLUID REPLACEMENT

Obtain IV access and commence fluid replacement immediately

If unable or poor IV access request critical care support immediately

Commence 0.9% saline - give 1 litre over 1 hour
- consider more rapid infusion if systolic BP<90 mmHg (with caution in elderly)

Catheterise within first 60 minutes to monitor fluid balance – minimum urine output 0.5 ml/kg/hr

Continue 0.9% saline giving 0.5 to 1 litre an hour

Aim to achieve- a gradual decline in osmolality of 3-8 mosmol/kg/hr
- 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 hours

Provided osmolality declining appropriately continue 0.9% saline (**even if plasma Na increasing**)

Adjust fluids as follows:

If osmolality increasing (or falling at rate <3 mosmol/kg/hr) and Na increasing check fluid balance
- if inadequate increase rate of infusion of 0.9% saline
- if adequate consider changing to 0.45% saline infused at same rate

If osmolality falling at rate > 8 mosmol/kg/hr consider
- reducing rate of IV fluids
- reduce rate if insulin infusion (if commenced)

If BG falling by <5 mmol/L check fluid balance
- if inadequate increase rate of infusion of 0.9% saline
- if adequate commence low dose iv insulin (0.05 units/kg/hr)
  (if already running increase rate to 0.1 units/kg/hr)

Continue IV fluids until eating and drinking normally

Maintain K within the normal range as follows:

Serum Potassium level - first 24 hr	KCl replacement per litre of fluid
>5.5 mmol/L	Nil
3.5 - 5.5 mmol/L	40 mmol/L
<3.5 mmol/L	Senior review - additional KCl required

INSULIN THERAPY

Commence at presentation only if significant ketonaemia
- capillary ketone > 1 mmol/L or > ++ urine ketones

Commence IV insulin if BG falling at rate <5 mmol/L despite adequate fluid replacement (see opposite)

Use low dose IV insulin infusion (IVII) – 0.05 units/kg/hr

Modify IVII as indicated (see opposite)

Aim to keep BG 10-15 mmol/L in first 24 hr

If BG falls <14 mmol/L commence 5 or 10% glucose at 125 ml/hr **in addition** to ongoing fluid replacement

REFER TO DIABETES TEAM AT EARLIEST OPPORTUNITY

MONITORING

Establish regime appropriate to patient

Patients should have continuous pulse oximetry and consider continuous cardiac monitoring

Monitor vital signs and chart Early Warning Score (EWS)

Assess for complications of treatment

Baseline investigations should include:

Capillary glucose	Blood cultures	FBC
Capillary ketones	Urinalysis and culture	U+E
Venous plasma glucose	CRP (if indicated)	ECG
Measured osmolality	Venous pH	CXR

OTHER MEASURES

Commence prophylactic low molecular weight heparin – continue for full length of stay
- consider longer duration of therapy if high risk of venous thromboembolism
- fully anti-coagulate if suspected thrombosis or ACS

Consider IV antibiotics if sepsis identified or suspected

Assess foot risk – assume high risk if obtunded or uncooperative

Off load heels and ensure daily foot checks

Assess mental state at baseline