MANAGEMENT OF HYPEROSMOLAR NONKETOTIC COMA (HONK)

Aetiology
- Dehydration syndrome due to hyperglycaemia
- Due to insufficient insulin to prevent hyperglycaemia but enough to prevent significant ketoacidosis
- Often develops during severe illness or physiologic stress in elderly patients either with no history of diabetes or with a history of NIDDM

Clinical Features
- Typical patient is an elderly nursing home resident
- Constitutional – malaise, weakness, myalgia
- Abdominal pain, nausea and vomiting
- Polyuria, polydipsia and loss of weight
- Signs of volume depletion and hypoperfusion +/- hypovolaemic shock
- Hyperventilation Kussmaul’s breathing in severe acidosis), ketotic breath, pyrexia
- Pyrexia
- Seizures or focal neurologic signs, stupor, coma
- Evidence of precipitating causes
  - Sepsis eg UTI, respiratory tract infection, bacterial meningitis, retropharyngeal abscess, hepatobiliary sepsis. Examine for sources of sepsis include “hidden” sites eg scalp, back, auditory meatus, perianal region
  - Noncompliance with diet or insulin therapy
  - Trauma
  - AMI
  - CVA
  - Pancreatitis
  - Parenteral glucose admin, TPN
  - Drugs: glucocorticoids, thiazides, phenytoin, β-blockers, calcium channel blockers

Laboratory Findings
- Severe hyperglycaemia (BSL>20mmol/L)
- Plasma hyperosmolality >320mmol/L; may cause neurologic symptoms
- Plasma osmolality = 2 x (Na + K) + glucose (mmol/L) + urea (mmol/)
- Marked free water deficit 6-18 litres (urea:creatinine ratio increased)
- Secondary glycosuria
- Absence of significant ketoacidosis
  - Metabolic acidosis absent or mild
  - Serum anion gap normal or slightly elevated
- HypoNa/hyperNa
- HypoNa+/hyperNa+
Hyponatraemia may be real (dilutional from osmotic effect of hyperglycaemia initially)
Or expected as a result of hyperglycaemia (correction factor: $\Delta Na = -0.016 \times (\text{glucose} - 100)$)
- HypoK/HypoPO4/HypoMg

Investigations
- CBC, U/Cr/Na/K/Cl/PO4/MgGlucose, ABG, serum osmolality
- Urine microscopy and culture
- Blood culture +/- lumbar puncture in a septic patient
- ECG
- CXR

Principles of Management
1. Aggressive fluid management
2. IV soluble insulin
3. Aggressive K replacement except in renal failure
4. Look for precipitating factors

Treatment
1. Fluid therapy
   - Aggressive fluid replacement about 2 L in 4 h, 1-2 L in the next 4 h; about 4-7 L in total within the first 24 h
   - NS is preferred because it helps to maintain intravascular volume and maintain peripheral perfusion. It may also reduce risk of cerebral oedema when sugar is lowered
   - ½ NS is used if serum Na >150-155mmol/L
   - Change to D5% with additional NaCl when blood sugar is <14mmol/L
   - Avoid alternating NS with dextrose drip as this will cause fluctuations in blood sugar
   - CVP/PCWP monitoring in patient with history of heart failure or renal impairment

2. Insulin therapy
   - Continuous IV insulin infusion (CI) through a pump is preferred as it offers smooth control. A more gradual normalization in the first 12-24 h period is preferred to avoid cerebral oedema. Loading dose of IV insulin does not result in better clinical outcome
   - Dilute 50 U of soluble insulin in 50 ml of gelofusine in a syringe and deliver it by an infusion pump
   - The average initial CI rate is about 0.1U/kg/h. It should preferably not exceed 10U/h for patient weight >70kg
• In severely insulin resistant cases eg morbid obesity, severe sepsis, high dose glucocorticoid treatment and TPN, a sliding scale with an initial rate of >10/h may be required
• Blood sugar should be monitored at 2-h intervals. Depending on whether the blood sugar improves 4 h later, the sliding scale may be switched to one with a higher initial CI rates (eg scale 1 to scale 3)

<table>
<thead>
<tr>
<th>BSL (mmol/L)</th>
<th>CI Scale 1 (U/h)</th>
<th>Scale 2</th>
<th>Scale 3</th>
<th>Scale 4</th>
<th>Scale 5</th>
<th>Scale 6</th>
<th>Scale 7</th>
</tr>
</thead>
<tbody>
<tr>
<td>≥ 22</td>
<td>3.0</td>
<td>4.0</td>
<td>5.0</td>
<td>6.0</td>
<td>7.0</td>
<td>8.0</td>
<td>10.0</td>
</tr>
<tr>
<td>18 -</td>
<td>2.5</td>
<td>3.5</td>
<td>4.0</td>
<td>5.0</td>
<td>6.0</td>
<td>6.0</td>
<td>8.0</td>
</tr>
<tr>
<td>14 -</td>
<td>2.0</td>
<td>3.0</td>
<td>3.0</td>
<td>4.0</td>
<td>5.0</td>
<td>5.0</td>
<td>6.0</td>
</tr>
<tr>
<td>12 -</td>
<td>1.5</td>
<td>2.5</td>
<td>2.5</td>
<td>3.0</td>
<td>4.0</td>
<td>4.0</td>
<td>4.0</td>
</tr>
<tr>
<td>10 -</td>
<td>1.0</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
<td>3.0</td>
<td>3.0</td>
<td>3.0</td>
</tr>
<tr>
<td>8 -</td>
<td>1.0</td>
<td>1.5</td>
<td>1.5</td>
<td>1.5</td>
<td>2.0</td>
<td>2.0</td>
<td>2.5</td>
</tr>
<tr>
<td>6 -</td>
<td>0.5</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.5</td>
<td>1.5</td>
<td>2.0</td>
</tr>
<tr>
<td>4 -</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>1.0</td>
<td>1.0</td>
<td>1.5</td>
</tr>
<tr>
<td>&lt; 4</td>
<td>Stop iv insulin infusion and inform doctor</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3. Potassium replacement
• Aggressive IV K⁺ infusion should be given in initial phase because of the shift of K⁺ with glucose into the intracellular compartment with hydration and insulin treatment
• In presence of ECG changes of hypokalaemia, 30 mmol of K⁺ diluted in 1 litre NS or ½ NS should be given over 1 h before laboratory confirmation is available. Checking of K⁺ usually available in our ICU – use ABG machine
• Replacement may be given according to the scale below:

<table>
<thead>
<tr>
<th>K⁺ level (mmol/L)</th>
<th>&lt; 3.0</th>
<th>3 -</th>
<th>4 -</th>
<th>5 -</th>
<th>&gt; 5.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>IV K⁺ (mmol/h)</td>
<td>30</td>
<td>20</td>
<td>10</td>
<td>5</td>
<td>0</td>
</tr>
</tbody>
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• Review K⁺ infusion rate when blood sugar is normalizing (<14mmol/L). K⁺ level should be measured every 4 h within the first 24 h

4. Bicarbonate/phosphate/magnesium
• If measured phosphate or magnesium is low, replacement can be given
• Mg²⁺ may be considered if arrhythmias occur

5. Venous thromboembolism prophylaxis
• Look under relevant chapter in the ICU manual
6. Termination of CI
Continuous insulin infusion can be stopped when:
- Blood sugar has been stabilized to ≤ 10 mmol/L on a steady insuling infusion rate for 12 h. The usual time frame is about 24-48 h of CI treatment
- Dehydration is almost corrected
- Precipitating factor is under control. If patient is still acutely ill, insulin resistance will be high and rebound in blood sugar is likely