THE MANAGEMENT OF DIABETIC KETOACIDOSIS IN ADULTS

Clinical History
• Polyuria
• Polydipsia
• Vomiting
• Abdominal pain
• Confusion
• ? Known Diabetes

Clinical Signs:
• Lethargy / confusion
• Smell of ketones
• Dehydration
• Kussmaul breathing
• Obtunded with any above

Biochemical Signs:
• Ketones in urine
• Raised blood glucose levels
• Acidotic
• Take blood for U&Es
• Look for any underlying cause (especially occult infection)

Diagnosis Confirmed: DIABETIC KETOACIDOSIS
pH <7.3, HCO3 <15, Urinary ketones ≥≥ ≥≥, Gluc >11

Clinical Signs:
• Shock
• Reduced conscious level
• Coma
• Profuse vomiting

Clinical Signs:
• Dehydration
• Clinically acidotic

Clinical Signs:
• No dehydration
• Clinically well
• Tolerating oral fluids

Resuscitation:
• Breathing - O2
• Circulation IV crystalloid/colloid until circulation restored
• Maintain airway
• ?NG tube required

Resuscitation:
• Correct fluid balance with 0.9% saline over 24-48 hrs tailored to individual needs (see protocol). CVP line may be needed if co morbidity
• Replace KCl – (see protocol).
• 6 units IV insulin per hr to start (use Adult IV insulin Prescription Chart regimen B)
• CONTINUE USUAL BASAL INSULIN - Gliargine (Lantus) or Detemir (Levemir)
• IV bicarbonate is needed very rarely and only after discussion with SpR/Cons.
• Monitor – see below

Resuscitation:
• Start s/c insulin
• Give oral fluids +++
• Monitor closely for deterioration
• Contact Diabetes Liaison Nurse to enable same day discharge. (M-F, Bleep 7721/7881) or Medical registrar (out of hours)

No Improvement:
• Check insulin infusion connected via the dedicated line and infusing?
• Continue 6U/hr with 10% dextrose (100ml/hr) if bl gluc <11 and HCO3 <15

Therapy:
• Start s/c insulin
• Give oral fluids +++
• Monitor closely for deterioration
• Contact Diabetes Liaison Nurse to enable same day discharge. (M-F, Bleep 7721/7881) or Medical registrar (out of hours)

Deteriorating neurological status
• Cerebral oedema
• Meningitis

Identify Underlying Cause:
• Sepsis
• MI
• Gastroenteritis
• Amylase may be mildly raised without pancreatitis
• “Regular attendees” may still have underlying cause. Rare attendees nearly always have

Observations:
• Hourly capillary blood glucose
• Neurological status hourly until stable
• Hourly fluid balance chart
• U&Es and venous HCO3 @ 2hrs/4hrs/8hrs/24hrs, or 2hrly if unstable
• ECG if co morbidity or unstable K+
• Urinary catheter if low output

Identify Underlying Cause:
• Sepsis
• MI
• Gastroenteritis
• Amylase may be mildly raised without pancreatitis
• “Regular attendees” may still have underlying cause. Rare attendees nearly always have

Good progress: reduction in BG 1-3 mmol/hr, good urine output and normal vital signs
• Review IV insulin prescription chart – does the sliding scale need adjusting?
• Ensure potassium is within normal range at all times
• Co-infuse 5% Dextrose blood glucose level <11mmol (or 10% dextrose if HCO3 still <15)
• Change to normal insulin regimen once eating and HCO3 >22
• For further details see full guidelines

DKA protocol_November 2008_FINAL
Dr A Ward
GUIDELINES FOR THE TREATMENT OF DIABETIC KETO ACIDOSIS (DKA) IN ADULTS

DEFINITION:
DKA is defined by the presence of ketonuria and acidosis, not the level of hyperglycaemia. (pH <7.3, HCO3 <15, Urinary ketones >++, Gluc >11)

If <18yrs/ears – please use paediatric DKA protocol (see intranet)
For hyper osmolar non-ketotic coma (HONC) please see appropriate guidelines

WHEN TO ADMIT TO HOSPITAL:
Patients with newly diagnosed Type 1 Diabetes (Insulin Dependent Diabetes) with ‘mild’ ketosis (not vomiting) and hyperglycaemia seldom need hospital admission. However these patients should be referred to the Diabetes Team that day.

Dr Reckless secretary: ext: 4527  Dr Higgs secretary: ext.: 4991
Dr Robinson secretary: ext: 4530  Dr Ward secretary: ext 6232
Registrar Bleep: 7021  Registrar Bleep: 7018
Diabetes Nurses: MON – FRI (9-5): EXT 4198 or BLEEP 7721/7881
Out of hours: on call medical team
Dr Reckless, Dr Higgs, Dr Robinson and Dr Ward can be contacted via switchboard.

Hospital admission is essential if the patient is acutely ill (e.g. vomiting, dehydrated), very young or elderly. These MUST be referred to the diabetes team as soon as possible. Pregnant women MUST be referred immediately.

PRECIPITATING FACTORS:
May include infection (occult) or failure to administer adequate amounts of insulin, but also intercurrent illness such as CVA, myocardial infarction etc.

INITIAL INVESTIGATIONS:

1. BLOOD GLUCOSE LEVELS:
   • Capillary blood glucose. NB. Blood glucose meters records to maximum 27.8 mmol/l. Higher readings are denoted as ‘HI’ on the meter.
   • Laboratory blood glucose: must be sent on all patients at outset and when monitoring patients with HI on meter

2. URINALYSIS:
   • All samples must be tested for ketones, protein, blood, leucocytes and nitrites

3. ARTERIAL BLOOD GASES: OR VENOUS BICARBONATE
   • pO2, pCO2, pH, HCO3, BE
   • Bottles must be full and sealed

4. U & Es:
   • including urea

5. SEPTIC SCREEN:
   • blood cultures
   • MSU: Must be sent as soon as possible if +ve dipstick
   • look for other sites of infection; especially feet
   • SCREEN BEFORE STARTING ANTIBIOTICS

6. OTHERS:
   • FBC - may be delayed until laboratory working hours (NB leucocytosis common – do not use as marker of infection)
   • ECG - where clinically indicated (consider occult MI in all patients>40 or with >10yr Hx DM)
   • Cardiac enzymes - where clinically indicated
   • Chest X - RAY - where clinically indicated
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TREATMENT:

Patients will require intensive monitoring and some will need to be admitted to ITU

In patients with depressed consciousness (Glasgow coma scale < 14) airways protection is vital as there is a high risk of aspiration. A large bore nasogastric tube should also be inserted if there is profuse vomiting suggestive of large volume gastric stasis.

All patients should have 2 good cannulae inserted; one for fluid replacement, the other for insulin (+ dextrose when needed). DO NOT USE FEET IN PATIENTS WITH DIABETES

Ensure ALL patients with DKA are referred to the Diabetes Liaison Nurses and transferred to Hamilton as soon as possible.

1. INSULIN:

a) Subcutaneous:
If the patient is normally on a basal bolus regimen with Glargine (Lantus) or Detemir (Levemir):
_Continue this at their usual dose and time IN ADDITION to intravenous insulin (EXPLAIN TO NURSES)_

b) Intravenous:
Use the RUH Adult Intravenous Insulin Prescription Chart Scale B.
Prepare as 1 unit per ml in 0.9% sodium chloride (e.g., 50 mls Actrapid in 50 mls N/saline)
Administer by continuous IV via a syringe driver.
NB. It is acceptable to use human insulin in patients who usually use animal insulin.

Always start infusion at 6U/hr

As long as subsequent measurements are improving, keep insulin infusion rate at 6u/hr. There is no benefit from speeding up the rate and this may be harmful.
If blood glucose shows no improvement - **check infusion pump is working correctly**!
If blood glucose shows no improvement and pump is satisfactory - increase infusion rate to 8u/hr.
If more than 8u/hr is needed, further increments should be by 6 u/hr. This MUST be discussed with Diabetes Team or on call medical registrar.

In addition to routine monitoring (see Page 5), check the venous bicarbonate as soon as the blood sugar drops below 11.
- If > 15 and improving, commence 5% dextrose 100ml per hour as co infusion with insulin (scale B)
- If < 15, start 10% dextrose 100ml/hr and continue IV insulin at 6U/hr until acidosis improved. Then revert to scale B with 5% dextrose.

<table>
<thead>
<tr>
<th>Blood glucose (mmol/l)</th>
<th>Insulin (U/hr)</th>
<th>Co-infusion (100ml/hr)</th>
<th>Additional Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;4 (recheck in 15mins)</td>
<td>0</td>
<td>5% Dextrose</td>
<td>Alert doctor if unwell or drowsy. If remains &lt;4 give Glucogel. If recurs, get doctor to change scale</td>
</tr>
<tr>
<td>4.1-6.5</td>
<td>1</td>
<td>5% Dextrose</td>
<td></td>
</tr>
<tr>
<td>6.6 – 8.9</td>
<td>2</td>
<td>5% Dextrose</td>
<td></td>
</tr>
<tr>
<td>9.0 – 11.0</td>
<td>4</td>
<td>5% Dextrose</td>
<td>If venous HCO3 remains &lt;15 – continue 6U/hr and co-infuse 10% Dextrose 100ml/hr</td>
</tr>
<tr>
<td>11.1 – 17</td>
<td>6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>17.1 - 28</td>
<td>6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt;28</td>
<td>6</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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2. FLUID REPLACEMENT: (If patient <20yrs and weighs <60kg – see Appendix 1)

If the patient is shocked (SBP <100), resuscitate with crystalloid (or colloid) 500ml over 15-20 mins. Repeat maximum of 3 times if necessary.

Adequate IV fluid replacement is vital - most patients are fluid depleted by 5 litres or more. **However it is important to replace the fluids over 24 hrs (ie not too quickly) to avoid cerebral oedema.**

Normal saline should be given in addition to IV dextrose (when this is needed to run with insulin) until fluid replacement is complete.

A typical regimen for a patient who is not shocked (SBP>100):

<table>
<thead>
<tr>
<th>Quantity of Fluid</th>
<th>Type of Fluid</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0 litre in first hour</td>
<td>0.9% saline</td>
</tr>
<tr>
<td>1.0 litre in next 2 hours</td>
<td>0.9% saline</td>
</tr>
<tr>
<td>1.0 litre in next 4 hours</td>
<td>0.9% saline</td>
</tr>
<tr>
<td>1.0 litre in next 4 hours</td>
<td>0.9% saline</td>
</tr>
<tr>
<td>1.0 litre in next 8 hours</td>
<td>0.9% saline</td>
</tr>
</tbody>
</table>

After the first hour of fluids please infuse all fluids via a pump

If patient has a cardiovascular history and/or is elderly (>65 yrs old) a CVP line and urinary catheter is mandatory.

Consider using 0.45% sodium chloride if serum sodium above 155 mmol/l and not falling. This should be discussed with the Diabetes Team or on call medical registrar.

3. POTASSIUM SUPPLEMENTS:

Do not give potassium in the initial litre of N Saline.

Once electrolytes available (from ABG), give according to the following algorithm:

<table>
<thead>
<tr>
<th>Potassium level</th>
<th>Replacement per litre fluid</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; 5.5</td>
<td>nil</td>
</tr>
<tr>
<td>4.0-5.5</td>
<td>20mmol</td>
</tr>
<tr>
<td>&lt;4.0</td>
<td>40mmol</td>
</tr>
</tbody>
</table>

Regular monitoring is essential (see below)

4. SODIUM BICARBONATE:

Not recommended unless pH <6.9 and venous bicarbonate <9 AND failing to improve despite other interventions (as above). Then give 50 mls of 1.45% sodium bicarbonate and repeat blood gases/bicarbonate 30mins later. If acidosis not improved, discuss with Diabetes Team / on call medical registrar and ITU.
5. ANTIBIOTICS:

These are not needed as part of routine care. If an infection is the likely precipitant to this episode of DKA, start antibiotics in accordance with the Hospital Antibiotic policy:


6. ANTICOAGULANTS:

All patients should be prescribed prophylactic Clexane (40mg sc od) unless contraindicated.

MONITORING THE TREATMENT OF DKA

1. BLOOD GLUCOSE MONITORING (BEDSIDE):
   Hourly until stabilised (usually 12 hours after admission) then reduce to 2 hourly. The optimum range is 4 - 9 mmol/l

2. SERUM:
   Check electrolytes (Na and K), glucose and HCO3 @ 2, 4, 8 and 24 hrs if the patient is progressing well. Check 2hrly if the patient is unstable.

3. BLOOD GASES:
   DO NOT perform repeated ABGs in patients with DKA unless there is a concurrent respiratory problem. Venous gases are sufficient to monitor the bicarbonate.

4. CARDIAC MONITORING:
   Indicated in the following situations:
   Patients > 45 years old.
   Hypertensive patients
   Patients where critical fluid balance monitoring is needed (e.g. elderly/cardiac failure)
   Abnormal ECG

5. Neurological
   Hourly neuro obs until stable

A FLUID BALANCE CHART MUST BE MAINTAINED

RESOLUTION

- Resume diet as soon as patient is able.
- Once eating, if the HCO3 is normal (>22), sub cut insulin should be resumed if the patient is well. Urinary ketones may take longer to clear.
- If the patient is on a basal bolus regimen and has continued their basal insulin (see above), give usual rapid acting insulin before the next meal and stop IV insulin 30 minutes after the meal.
- If patient is on a BD regimen insulin infusion is to be stopped at lunchtime, give half normal breakfast dose before lunch and stop IV insulin 30mins after lunch. Recomence usual BD regimen with evening meal. At breakfast or tea, give usual insulin and disconnect pump 30 mins later.
- If patient is newly diagnosed with Type 1 Diabetes and Diabetes Team not available then start patient on Human Mixtard 30: 10 units before breakfast and evening meal.
Appendix 1

FLUID REPLACEMENT FOR ADULTS <20YRS AND WEIGHING <60KG (taken from paediatric DKA protocol)

1. Assess degree of dehydration

3% dehydration is only just clinically detectable  
mild: 5% - dry mucous membranes, reduced skin turgor  
moderate: 7.5% - above with sunken eyes, poor capillary return  
severe: 10% (+ shock) - severely ill with poor perfusion, thready rapid pulse, (reduced blood pressure is not likely and is a very late sign)

2. Resuscitation

If shocked (SBP<100): give 500ml 0.9% Saline over 15-20mins. Can be repeated if necessary – max 3x total

3. Fluid requirements

N.B. It is essential that all fluids given are documented carefully, particularly the fluid which is given in Casualty and on the way to the ward, as this is where most mistakes occur.

a) Volume of fluid -  
By this stage, the patient should no longer be shocked

Requirement = Maintenance + Deficit  
Deficit (litres) = % dehydration x body weight (kg)  
Ensure this result is then converted to ml.  
Never use more than 10% dehydration in the calculations.  
Maintenance requirements: 30 ml/kg/24 hrs  
Add calculated maintenance (for 48 hrs) and estimated deficit, subtract the amount already given as resuscitation fluid, and give the total volume evenly over the next 48 hours. i.e.

Hourly rate = \frac{48 \text{ hr maintenance} + \text{deficit} - \text{resuscitation fluid already given}}{48}

Example:  
A 50 kg 18 year old girl who is 10% dehydrated, and who has already had 500ml saline, will require
• 10 % x 50 kg = 5000 mls deficit  
• plus 30ml x 50kg = 1500 mls maintenance each 24 hours  
48hr total= 8000 mls (5000+1500+1500)  
• minus 500 mls resus fluid  
7500 mls over 48 hours = 156 mls/hour

Do not include continuing urinary losses in the calculations
b) Type of fluid
Initially use 0.9% saline.
Generally once the blood glucose has fallen to 14-17 mmol/l add glucose to the fluid. If this occurs within the first 6 hours, the patient may still be sodium depleted. Discuss this with consultant, who may wish to continue with Normal saline and added dextrose. If this occurs after the first 6 hours and the child's plasma sodium level is stable, change the fluid type to 0.45% saline/5% dextrose. Check U & E’s 2 hours after resuscitation is begun and then at least 4 hourly
Electrolytes on blood gas machine can be helpful for trends whilst awaiting laboratory results.

c) Oral Fluids :
• In severe dehydration, impaired consciousness & acidosis do not allow fluids by mouth. A NG tube may be necessary in the case of gastric paresis.
• Oral fluids (eg fruit juice/oral rehydration solution) should only be offered after substantial clinical improvement and no vomiting
• When good clinical improvement occurs before the 48hr rehydration calculations have been completed, oral intake may proceed and the need for IV infusions reduced to take account of the oral intake.

3. Potassium
Once the patient has been resuscitated, potassium should be commenced immediately with rehydration fluid unless anuria is suspected. Potassium is mainly an intracellular ion, and there is always massive depletion of total body potassium although initial plasma levels may be low, normal or even high. Levels in the blood will fall once insulin is commenced. Therefore initially add 20 mmol KCl to every 500 ml bag of fluid (40 mmol per litre). Check U & E’s 2 hours after resuscitation is begun and then at least 4 hourly, and alter potassium replacements accordingly. There may be standard bags available; if not, strong potassium solution may need to be added, but always check with another person. Use a cardiac monitor and observe frequently for T wave changes.