The Management of Diabetic Ketoacidosis in Adults

For young people under the age of 18 years use British Society of Paediatric Endocrinology and Diabetes (BSPED) guidelines: http://www.bsyped.org.uk/professional/guidelines/docs/DKAGuideline.pdf

Diagnostic criteria: all three of the following must be present
- capillary blood glucose above 11 mmol/L
- capillary ketones above 3 mmol/L or urine ketones ++ or more
- venous pH less than 7.3 and/or bicarbonate less than 15 mmol/L

**BOX 1: Immediate management: time 0 to 60 minutes (T=0 at time intravenous fluids are commenced)**

**If intravenous access cannot be obtained request critical care support immediately**

**Action 1:** Commence 0.9% sodium chloride solution (via large bore cannula) via infusion pump.
- See Box 2 for rate of fluid replacement

**Action 2:** Commence a fixed rate intravenous insulin infusion (IVI).
- 0.1U/kg/hr based on estimate of weight. 50 units human soluble insulin (Humulin R or Humulin N) made up to 50ml with 0.9% sodium chloride solution. If patient normally takes long acting insulin analogue (Lantus® or Levemir®) continue at usual dose and time

**Action 3:** Assess patient
- Respiratory rate, temperature, blood pressure, pulse, oxygen saturation
- Glasgow Coma Scale
- Full clinical examination

**Action 4:** Further investigations
- Capillary and laboratory glucose
- Venous BS
- U & E
- FBC
- Blood cultures
- ECG
- CXR
- MSU

**Action 8:** Establish monitoring regimen
- Hourly capillary blood glucose
- Hourly capillary ketone measurement if available
- Venous bicarbonate and potassium at 60 minutes, 2 hours and 2 hours thereafter
- 4 hourly plasma electrolytes
- Continuous ECG monitoring if required
- Full clinical examination

**Action 6:** Consider and precipitating causes and treat appropriately

**BOX 6: Resolution of DKA**

**Expectation:** Patient should be eating and drinking back on normal insulin.
- If DKA not resolved identify and treat the reasons for failure to respond.
  - Situational and requires senior and specialist input.
- Transfer to subcutaneous insulin
  - Convert to subcutaneous regime when biochemically stable (capillary ketones less than 0.3 mmol/L, pH over 7.35 and the patient is ready and able to eat. Do not discontinue intravenous insulin infusion until 30 minutes after subcutaneous short acting insulin has been given
  - Conversion to subcutaneous insulin should be managed by the Specialist Diabetes Team. If the team is not available use local guidelines. If the patient is newly diagnosed it is essential they are seen by a member of the specialist team prior to discharge.
  - Arrange follow up with specialist team.

**HDU/level 2 facility and/or insertion of central line may be required in following circumstances (request urgent senior review)**
- Young people aged 18-25 years
- Elderly
- Pregnant
- Heart or kidney failure
- Other serious co-morbidities
- Severe DKA by following criteria
  - Blood ketones above 6 mmol/L
  - Venous bicarbonate below 5 mmol/L
  - Venous pH below 7.1
  - Hypokalaemia on admission (below 3.5 mmol/L)
  - GC5 less than 12
  - Oxygen saturation below 95% on an arterial blood gases sample
  - Systolic BP below 90 mmHg
  - Pulse over 100 or below 60 bpm
  - Anion gap above 16 (Anion Gap = Na+ – K+ – (Cl– + HCO3–))

**Box 3**

**Aims of treatment:**
- Rate of fall of ketones of at least 0.5 mmol/L/hr and blood glucose fall of 3 mmol/L/hr
- Maintain serum potassium in normal range
- Avoid hypoglycaemia

**Action 1:** Re-assess patient, monitor vital signs
- Hourly blood glucose (lab blood glucose if meter reading ‘HI’)
- Hourly blood ketones if meter available
- Venous blood gas for pH, bicarbonate and potassium at 60 minutes, 2 hours and 2 hours thereafter
- If potassium is outside normal range, re-assess potassium replacement and check if abnormal after further hour to establish immediate senior medical advice

**Action 2:** Continue fluid replacement via infusion pump as follows:
- 0.9% sodium chloride 1L, with potassium chloride over next 2 hours
- 0.9% sodium chloride 1L, with potassium chloride over next 2 hours
- 0.9% sodium chloride 1L, with potassium chloride over next 4 hours
- Add 10% glucose 12.5mmol/hr if blood glucose falls below 14mmol/L

**More cautious fluid replacement in young people aged 18-25 years, elderly, pregnant, heart or renal failure. (Consider HDU and/or central line)**

**Action 3:** Assess response to treatment
- Insulin infusion rate may need review if
  - Capillary ketones not falling by at least 0.5 mmol/L/hr
  - Venous bicarbonate not rising by at least 3 mmol/L/hr
  - Plasma glucose not falling by at least 3 mmol/L/hr
  - Continue fixed rate IVI until ketones less than 0.3 mmol/L, venous pH over 7.3 and/or venous bicarbonate over 18 mmol/L.

**If ketones and glucose are not falling as expected always check the infusion pump is working and connected and that the correct insulin residual volume is present (to check for pump malfunction).**
- If equipment working but response to treatment inadequate, increase insulin infusion rate by 1 U/HR increments hourly until targets achieved.

**Additional measures**
- Regular observations and Blood Glucose control
- Accurate fluid balance chart, minimum urine output 0.5ml/kg/Hr
- Consider urinary catheterisation if incontinent or unresponsive (was used by 60% of patients)
- Nasogastric tube with airway protection if patient obtunded or persistently vomiting
- Measure arterial blood gases and repeat chest radiograph if oxygen saturation less than 92%
- Thrombin prophylaxis with low molecular weight heparin
- Consider ECG monitoring if potassium abnormal or concerns about cardiac status

**Aims:**
- Ensure clinical and biochemical parameters improving
- Continue iv fluid replacement
- Avoid hypoglycaemia
- Assess for complications of treatment e.g. fluid overload, cerebral oedema
- Treat precipitating factors as necessary

**Action 1:** Re-assess patient, monitor vital signs
- If patient not responding by criteria in Box 3 seek senior advice
- Continue iv fluid infusion pump at reduced rate.
- o 0.9% sodium chloride 1L, with potassium chloride over 4 hours
- o 0.9% sodium chloride 1L, with potassium chloride over 6 hours
- Add 10% glucose 12.5mmol/hr if blood glucose falls below 14mmol/L

**Reassess cardiovascular status at 12 hours; further fluid may be required.**

**Check for fluid overload**

**Action 2:** Review biochemical and metabolic parameters
- At 12 hours check venous pH, bicarbonate, potassium, capillary ketones and glucose
- Resolution is defined as ketones <0.3 mmol/L, venous pH>7.3,
- If not resolved review Box 4

**Action 3:**
- Transfer to subcutaneous insulin

**If DKA not resolved, go to Box 6**

**BOX 4: 6 to 12 hours**

**Aims:**
- Ensure clinical and biochemical parameters improving
- Continue iv fluid replacement
- Assess for complications of treatment e.g. fluid overload, cerebral oedema
- Treat precipitating factors as necessary

**Action 1:** Re-assess patient, monitor vital signs
- If patient not responding by criteria in Box 3 seek senior advice
- Continue iv fluid infusion pump at reduced rate.
- o 0.9% sodium chloride 1L, with potassium chloride over 4 hours
- o 0.9% sodium chloride 1L, with potassium chloride over 6 hours
- Add 10% glucose 12.5mmol/hr if blood glucose falls below 14mmol/L

**Reassess cardiovascular status at 12 hours; further fluid may be required.**

**Check for fluid overload**

**Action 2:** Review biochemical and metabolic parameters
- At 6 hours check venous pH, bicarbonate, potassium, capillary ketones and glucose
- Resolution is defined as ketones <0.3 mmol/L, venous pH>7.3 (do not use bicarbonate as a surrogate at this stage)
- Ensure referral has been made to diabetes team

**If DKA not resolved review insulin infusion (see BOX 3)**

**Action 3:**
- If DKA resolved go to BOX 6

**Groups represented:** Association of British Clinical Diabetologists; British Society for Endocrinology and Diabetes and Association of Children’s Diabetes Clinicians; Diabetes Inpatient Specialist Nurse (DISN) Group; Diabetes UK; NHS Diabetes (England); Northern Irish Diabetologists; Society of Acute Medicine; Welsh Endocrine and Diabetes Society; Scottish Diabetes Group.