

Single page treatment pathway for DKA

Where individuals aged 16-18 are managed by paediatric teams, the paediatric guidelines should be followed:

BSPED IBSPED DKA Guidelines

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 (use a large bore cannula) via an infusion pump
See Box 2 for rate of fluid replacement
- Action 2:** Commence a fixed rate intravenous insulin infusion (FRILI). (0.1 unit/kg/hr based on estimate of weight) 50 units human soluble insulin (Actrapid® or Humulin S®) made up to 50ml with 0.9% sodium chloride solution. If patient normally takes long acting insulin analogue (glargine, detemir, degludec) continue at usual dose and time
- Action 3:** Assess patient
o Respiratory rate; temperature; blood pressure; pulse; oxygen saturation
o Glasgow Coma Scale
o Full clinical examination
- Action 4:** Further investigations
• Capillary and laboratory glucose
• Venous BG
• U&E and FBC
• Blood cultures
• ECG
• CXR
• MSU
- Action 5:** Establish monitoring regimen
• Hourly capillary blood glucose
• Hourly capillary ketone measurement if available
• Venous bicarbonate and potassium at 60 minutes, 2 hours and 2 hourly thereafter
• 4 hourly plasma electrolytes
• Continuous cardiac monitoring if required
• Continuous pulse oximetry if required
- Action 6:** Consider and precipitating causes and treat appropriately

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 7.0
 - Hypokalaemia on admission (below 3.5 mmol/L)
 - GCS less than 12
 - Oxygen saturation below 92% on air (Arterial blood gases required)
 - Systolic BP below 90 mmHg
 - Pulse over 100 or below 60 bpm
 - Anion gap above 16 [Anion Gap = $(\text{Na}^+ + \text{K}^+) - (\text{Cl}^- + \text{HCO}_3^-)$]

BOX 2: Initial fluid replacement

Restoration of circulating volume is priority

Systolic BP (SBP) below 90mmHg

Likely to be due to low circulating volume, but consider other causes such as heart failure, sepsis, etc.

- Give 500mls 0.9% sodium chloride solution over 10-15 minutes. If SBP remains <90mmHg repeat whilst awaiting senior input. Most people require between 500-1000mls given rapidly
- Consider involving the ITU / critical care team
- Once SBP is >90mmHg, give 1L 0.9% sodium chloride over the next 60 minutes. The addition of potassium is likely to be required in this second litre of fluid

Systolic BP on admission 90 mmHg and over

- Give 1L 0.9% sodium chloride over the first 60 minutes

Potassium replacement Potassium level (mmol/L)	Potassium replacement mmol/L of infusion solution
> 5.5	Nil
3.5-5.5	40 mmol/L
< 3.5	senior review – additional potassium required

BOX 3: 60 minutes to 6 hours

Aims of treatment:

- Rate of fall of ketones of at least 0.5 mmol/L/hr OR bicarbonate rise 3 mmol/L/hr and blood glucose fall 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 hourly thereafter
- If potassium is outside normal range, re-assess potassium replacement and check hourly. If abnormal after further hour seek 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 125ml/hr if blood glucose falls below 14 mmol/L
- **Consider** reducing the rate of intravenous insulin infusion to 0.05 units/ kg/hour when glucose falls below 14 mmol/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 FRILI until ketones less than 0.6 mmol/L, venous pH >7.3 and/or venous bicarbonate over 18 mmol/L

If ketones and glucose are not falling as expected always check the insulin 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 is inadequate, increase insulin infusion rate by 1 unit/hr increments hourly until targets achieved.

Additional measures

- Regular observations and Early Warning Score (NEWS2)
- Accurate fluid balance chart, minimum urine output 0.5ml/kg/hr
- Consider urinary catheterisation if incontinent or anuric (not passed urine) by 60 minutes
- 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%
- Thromboprophylaxis with low molecular weight heparin
- Consider ECG monitoring if potassium abnormal or concerns about cardiac status

BOX 4: 6 to 12 hours

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 improving by criteria in Box 3, seek senior advice
- Continue IV fluid via infusion pump at reduced rate
 - o 0.9% sodium chloride 1L with KCl over 4 hours
 - o 0.9% sodium chloride with KCl over 6 hours
- Add 10% dextrose 125mls/hr if the glucose falls below 14 mmol/L
- **Consider** reducing the rate of intravenous insulin infusion to 0.05 units/ kg/hour when glucose falls below 14 mmol/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 of DKA is defined at ketones <0.6 mmol/L AND venous pH >7.3 (do not use bicarbonate as a marker at this stage)
- Ensure a referral has been made to the diabetes team
- **If DKA not resolved review insulin infusion (see BOX 3 Action 3)**
- **If DKA resolved go to BOX 6**

BOX 5: 12 to 24 HOURS

Expectation: By 24 hours the ketonaemia and acidosis should have resolved. Request senior review if not improving

Aim:

- Ensure that clinical and biochemical parameters are continuing to improve or are normal
- Continue IV fluid replacement if not eating and drinking
- If ketonaemia has cleared and the person is not eating or drinking, move to a variable rate intravenous insulin infusion (VRILI) as per local guidelines
- Reassess for complications of treatment, e.g. fluid overload, cerebral oedema
- Continue to treat precipitating factors
- Transfer to subcutaneous insulin if the person is eating and drinking normally and biochemistry is normal

Action 1 – Re-assess patient, monitor vital signs

Action 2 – Review biochemical and metabolic parameters

- At 12 hours check venous pH, bicarbonate, potassium, capillary ketones and glucose
- Resolution is defined as ketones <0.6 mmol/L, venous pH >7.3
- If not resolved review fluid Box 4 Action 1 and insulin infusion Box 3 Action 3

Action 3

If DKA resolved go to Box 6

BOX 6: Resolution of DKA

Expectation: Patient should be eating and drinking and back on normal insulin

If DKA not resolved identify and treat the reasons for failure to respond.

This situation is unusual and requires senior and specialist input

Transfer to subcutaneous insulin

Convert to subcutaneous regime when biochemically stable (capillary ketones less than 0.6 mmol/L AND pH over 7.3) 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

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Association of British Clinical Diabetologists

WEDS
Welsh Endocrine and Diabetes Society

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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; Diabetes Network Northern Ireland; Society of Acute Medicine; Welsh Endocrine and Diabetes Society, Scottish Diabetes Group.