Integrated care pathway for the management of children and young people with Diabetic Ketoacidosis

If you are not experienced in managing children in DKA, ask for senior help now.

Affix sticker or complete patient demographics below

<table>
<thead>
<tr>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date of Birth</td>
</tr>
<tr>
<td>Hospital / NHS Number</td>
</tr>
</tbody>
</table>

**DKA protocol started at:**

- hh:mm
- dd/mm/yyyy

**IMPORTANT SAFETY NOTES:**

These are general guidelines for management. Treatment may need modification to suit the individual patient and these guidelines do not remove the need for frequent detailed reassessments of the individual patient’s requirements and specific treatment tailored to those requirements.

This integrated care pathway (ICP) is designed to be used by, or under the supervision of, clinicians experienced in the management of paediatric DKA. It should be used in conjunction with the full BSPED DKA 2020 guideline on which it is based which can be found at: [https://www.bsped.org.uk/clinical-resources/guidelines/](https://www.bsped.org.uk/clinical-resources/guidelines/)

This is part of the official patient care record and should be filed in the patient’s notes. All professionals involved must document any intervention carried out. When filling out a flow chart, you must complete the box in the lower right corner of the chart with your signature, name, and the date and time. Any variation from the care plan must be documented.

[www.dka-calculator.co.uk](http://www.dka-calculator.co.uk)

This ICP is designed in conjunction with an online calculator that will pre-fill elements, for example patient demographics and fluid calculations. While the ICP can be used without this step, use of the calculator is strongly advised as it reduces the risk of calculation errors. The calculator is also important for the national DKA audit programme. No patient identifiable data is transmitted or stored when using the online calculator. Access the calculator at the web address above.
INTRODUCTORY NOTES

This ICP is designed to be worked through and completed to aid with management decisions and to record important events. You should start with flow chart 1 - ASSESSMENT & DIAGNOSIS - on page 3, and proceed as shown in the guidance below. Remember to refer to the additional guidance in the appendicies if you are not already familiar with it.

The flow charts are structured in a systematic way as follows:

- Indicates the start of a flow chart, showing how it was reached.
- The blank space indicates an entry to be completed by the clinician. A green tick icon indicates that an entry is part of the national DKA audit programme.
- Indicates a tick box option.
- Indicates a decision point. Follow the appropriate arrow to continue.
- Shows additional critical or useful guidance.
- Indicates the end of a flow chart sequence, showing which flow chart to use next.

The ICP is divided into sections which are identified by coloured borders at the side of each page.

MAIN PROTOCOL SECTION
Page 3 – Flow Chart 1 – ASSESSMENT & DIAGNOSIS
Page 4 – Flow Chart 2 – RESUSCITATION
Page 5 – Flow Chart 3 – SECONDARY REVIEW
Page 6 – Flow Chart 4 – FLUIDS
Page 7 – Flow Chart 5 – INSULIN
Page 8 – Flow Chart 6 – MONITORING & REVIEWS
Page 9 – Flow Chart 7 – ONGOING MANAGEMENT
Page 10 – Table 1 – SERIAL DATA SHEET

COMPLICATIONS SECTION
Page 11 – Flow Chart 8 – CEREBRAL OEDEMA
Page 11 – Flow Chart 9 – HYPOKALAEMIA
Page 12 – Flow Chart 10 – HYPOGLYCAEMIA
Page 12 – Flow Chart 11 – PERSISTING ACIDOSIS
Page 13 – Flow Chart 12 – HYPEROSMOLAR HYPERGLYCAEMIC STATE

APPENDICIES SECTION
Page 14 – Appendix 1 – GLASGOW COMA SCORE
Page 14 – Appendix 2 – ESTIMATED WEIGHT TABLE
Page 15 – Appendix 3 – MAKING UP IV FLUIDS
Page 15 – Appendix 4 – EXPLANATORY NOTES
Patient Name:  
Date of Birth:  
Hospital / NHS Number:  

Clinical History:  
- Polyuria/polydipsia  
- Weight loss  
- Abdominal pain  
- Weakness  
- Vomiting  
- Confusion  

Biochemistry:  
- Hyperglycaemia (>11mmol/L)  
- Acidaemia (pH<7.3)  
- Ketosis (blood ketones >3mmol/L or urine ketones ++)

Clinical Signs:  
- Dehydration  
- Kussmaul breathing (deep, sighing)  
- Ketotic smell  
- Lethargy, drowsiness

Suspect DKA

Check: Blood Glucose  
Blood Ketones  
Blood Gas

Record initial values:

<table>
<thead>
<tr>
<th>Glucose</th>
<th>mmol/L</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td></td>
</tr>
<tr>
<td>Ketones</td>
<td>mmol/L</td>
</tr>
<tr>
<td>Bicarb.</td>
<td>mmol/L</td>
</tr>
</tbody>
</table>

Blood glucose levels are generally high (above 11mmol/L) but children and young people with known diabetes may develop DKA with normal blood glucose levels.

Consider new diabetes not in DKA  
Use local guidelines

Raised blood glucose, pH >7.3 AND bicarbonate >15mmol/L

Go to flowchart 12 HYPERSOMOLAR HYPERGLYCAEMIC STATE  
Page 13

Very high blood glucose (>35mmol/L), No significant ketosis (<3mmol/L) OR acidosis (pH>7.3, bicarb. >15mmol/L)

Diagnose DKA

Perform rapid emergency assessment

Record your initial assessment here and use this to guide your management on the following page

Airway  
Maintaining own airway?  
Yes  
No

Breathing  
RR  
/min  
SpO2  
%

Circulation  
HR  
/min  
CRT  
secs  
Clinically shocked?  
Yes  
No

Disability  
GCS  
/15  
M:  
V:  
E:  

See also page 4

See also appendix 1 page 14

Further details:

Children who are alert, not clinically dehydrated, not nauseated or vomiting, do not always require IV fluids, even if their ketone levels are high. They usually tolerate oral rehydration and subcutaneous insulin but do require monitoring regularly to ensure that they are improving and their ketone levels are falling. This decision should be made in consultation with the responsible paediatrician.

Go to flowchart 2 RESUSCITATION  
Page 4

Chart completed by:  
GMC number:  
Signature:  
Time / Date:  
**FLOW CHART 2 – RESUSCITATION**

**A:** Establish airway: Seek urgent anaesthetic review if unable to protect airway. If child comatose: Insert NG tube on free drainage.

**B:** Give O₂ 100% via face mask with reservoir bag (only omit if child very well).

**C:** Establish IV access (consider 2nd cannula for later blood samples), take bloods (see box). Commence cardiac monitoring (peaked T waves may indicate hyperkalaemia).

For estimated weight:
- Refer to appendix 2, page 14
- Ensure an accurate weight is obtained before starting maintenance fluids

**Recommended bloods:**
- Blood ketones
- Blood gas
- HbA₁<sub>c</sub>
- FBC, U+E, CRP
- Lab glucose

For patients newly diagnosed:
- T3Ts
- TTG
- Additional bloods as per your local policy

**Is the patient shocked?**

**Shocked patients should be discussed with the most senior paediatrician or intensivist at the earliest opportunity.**

**Yes**

- Shocked patients: 20 ml/kg bolus of 0.9% saline or plasmalyte over 15 minutes
  - **Volume:** __________ ml
  - **Started:** __________ dd/mm/yyyy

  Reassess: if still shocked further boluses of 10 ml/kg (up to total of 40 ml/kg) may be given
  - **Volume:** __________ ml
  - **Started:** __________ dd/mm/yyyy

If still shocked consider inotropes and critical care escalation

**No**

- All non-shocked children with mild, moderate or severe DKA should receive a 10 ml/kg bolus of 0.9% saline over 1 hour
  - **Volume:** __________ ml
  - **Started:** __________ dd/mm/yyyy

Whilst excessive fluid should be avoided because of the risk of cerebral oedema, it is important to ensure that the circulation is adequate and fluid should be given to support this. Cerebral perfusion is dependent on both perfusion pressure and intracranial pressure, and hypotension will exacerbate the risk of brain injury.

A bolus given on this arm is later subtracted from the calculated fluid deficit, whereas boluses for shocked patients are not. See page 6 for details.

Do NOT give IV sodium bicarbonate to patients with DKA. See appendix 4, page 16, for more information.

**D:** Consider if cerebral oedema may be present

Early manifestations: headache, agitation/irritability, unexpected fall in heart rate, rise in blood pressure

Additional manifestations: deterioration in conscious level, abnormal breathing pattern, ocuulomotor palsy, abnormal posturing, pupil inequalities or dilatation

Go to flow chart 3
SECONDARY REVIEW
Page 5

Go to flow chart 8
CEREBRAL OEDEMA
Page 11
Patient Name:
Date of Birth:
Hospital / NHS Number:

History:

Past medical history:

Drug history:

Family and social history:

Examination:

DKA may be precipitated by sepsis or intercurrent infection, and fever is not part of DKA. Infection may co-exist with DKA. Suspect sepsis if there is fever or hypothermia, hypotension, refractory acidosis or lactic acidosis. A high lactate should increase concern about possible infection or sepsis.
FLOW CHART 4 - FLUIDS

Patient Name:
Date of Birth:
Hospital / NHS Number:

To avoid excessive amounts of fluid in overweight and obese children it is recommended that consideration be given to using a maximum weight of 80kg or 98th centile weight for age (whichever is lower) when calculating both deficit and maintenance requirements. Please refer to the full BSPED guidelines for further information.

**Fluid calculations**

\[
\text{Fluid deficit} = \text{Patient weight} \times \% \text{ Dehydration} \times 10 = \text{mL}
\]

\(\text{e.g. } 22\text{kg} \times 7\% \times 10 = 1540\text{mL}\)

**Subtract ONLY the 10mL/kg bolus given over 1 hour to non-shocked patients. DO NOT subtract rapid resuscitation boluses given to shocked patients.**

**Deficit replacement rate**

\[
\frac{\text{Fluid deficit} \text{ (less bolus volume)}}{48 \text{ hours}} = \text{mL/hour}
\]

\(\text{e.g. } 1320\text{mL} \div 48 \text{ hours} = 27.5\text{mL/hour}\)

**Maintenance rate**

\[
\frac{\text{Daily fluid requirement}}{24 \text{ hours}} = \text{mL/hour}
\]

\(\text{e.g. (for 22kg) } \frac{(1000\text{mL}+500\text{mL}+40\text{mL})}{24 \text{ hours}} = 64.2\text{mL/hour}\)

**STARTING FLUID RATE (after bolus complete)**

\[
\frac{\text{Maintenance rate}}{\text{hour}} + \frac{\text{Deficit replacement rate}}{\text{hour}} = \text{mL/hour}
\]

\(\text{e.g. } 64.2\text{mL/hour} + 27.5\text{mL/hour} = 91.7\text{mL/hour}\)

**Plasmalyte 148 can be used as an alternative to 0.9% Sodium Chloride but must have added potassium.**

If potassium is above normal range add potassium to fluids only after the patient has passed urine or after the Potassium has fallen to within the normal range.

**Once initial bolus is complete:**
Start 0.9% Sodium Chloride + 20mmol Potassium Chloride in 500mL at STARTING FLUID RATE as above

**Fluid start time / date**

\(\text{hh:mm dd/mm/yyyy}\)

**Go to flow chart 5: INSULIN Page 7**

**Chart completed by:**

**GM number:**

**Signature:**

**Time / Date:**
FLOW CHART 5 - INSULIN

From flow chart 4 FLUIDS

Wait for 1-2 hours after starting IV fluid treatment before starting insulin

Starting insulin early may increase the risk of cerebral oedema

Insulin hourly rate = 0.05-0.1 Units/kg/hour x Patient weight kg = Units/hour

e.g. 22kg x 0.05 Units/kg/hour = 1.1 Units/hour

Use pre-filled syringes containing 50 Units of soluble insulin in 50mL 0.9% Sodium Chloride where available. If pre-filled syringes are not available, add 50 Units of soluble insulin (e.g. Actrapid) to 49.5mL 0.9% Sodium Chloride.

Start at INSULIN HOURLY RATE as calculated above:

Insulin start time / date: hh:mm dd/mm/yyyy

Pre-existing diabetes?

Yes

Patients on insulin pumps (CSII) should have their pump stopped once IV insulin is started.

Pump stopped? Yes No N/A

For patients already on long-acting insulin consider continuing at the usual dose and time throughout the DKA treatment, in addition to the IV insulin infusion, in order to shorten length of stay after recovery from DKA.

Long-acting insulin continued? Yes No N/A

No

If supported by your local guidelines, consider starting an appropriate dose of long-acting background insulin alongside the intravenous infusion.

Long-acting insulin started? Yes No

Go to flow chart 6 MONITORING & REVIEWS Page 8

Chart completed by: ____________________________
GMC number: ____________________________
Signature: ____________________________
Time / Date: ____________________________
Consider where the child or young person should be nursed:
Patients with DKA should be cared for with one-to-one nursing if:
- they are younger than 2 years or
- they have severe DKA (blood pH below 7.1)
If one-to-one nursing cannot be provided on HDU/general paediatric ward, consider transfer to PICU.

Nursing Observations - ensure full instructions are given to nurse responsible including:
- Strict fluid balance including oral fluids and urine output, using fluid balance charts (urinary catheterisation may be necessary in young/sick children)
- Hourly capillary blood glucose measurements
- Capillary blood ketone levels every 1-2 hours
- Hourly BP and basic observations
- Hourly level of consciousness initially, using the modified Glasgow Coma Score
- In children < 2 years of age and in those with a pH < 7.1 (at increased risk of cerebral oedema): Half-hourly neurological observations including the modified Glasgow Coma Score and heart rate
- Report immediately to medical staff:
  - symptoms of headache, or slowing of heart rate, or any change in either conscious level or behaviour
  - any changes in the ECG trace, especially signs of hypokalaemia, including ST-segment depression and prominent U-waves
- Twice daily weight; can be helpful in assessing fluid balance

Medical Reviews
- At 2 hours after starting treatment and then at least every 4 hours carry out and record the results of the following blood tests on the SERIAL DATA SHEET (page 10):
  - Glucose (Laboratory measurement)
  - Blood gas (for pH and pCO₂)
  - Plasma U+Es - ensure samples are sent urgently to the lab
  - Blood ketones
- A doctor (or equivalent practitioner) should carry out a face-to-face review at the beginning of treatment, at 2 hours after starting treatment, and then at least every 4 hours and more frequently if:
  - child is aged under 2 years
  - has severe DKA (pH < 7.1)
  - there are any other reasons for special concern
- At each face-to-face review, provide an update on progress to the child or young person and their family and carers (as appropriate), and assess the following:
  - Clinical status, including vital signs and neurological status
  - Results of blood investigations
  - ECG trace (especially signs of hypokalaemia, including S-T segment depression and prominent U-waves)
  - Cumulative fluid balance record
- Ensure that each review is documented in the patient's medical notes, including the components described above.
- Consider adjusting the total fluid rate using corrected sodium (Na⁺_corr) (see also appendix 4, page 15) taking into account the circulation and patient's general condition and state of hydration:
  - If the rise in Na⁺_corr is >5mmol/L in 4-8 hrs it suggests too much fluid loss or insufficient replacement. Consider increasing the fluid rate
  - If there is a fall in Na⁺_corr by more than 5mmol/L in 4-8 hrs it suggests too much fluid gain or too rapid replacement. Consider reducing the fluid rate

At each review confirm monitoring is compliant with the requirements above. Give specific consideration to the issues below. Address these in order of clinical priority.

- **Features of cerebral oedema?**
  - No
  - Yes
    - Go to flow chart 8 CEREBRAL OEDEMA Page 11

- **Hypokalaemia?**
  - No
  - Yes
    - Go to flow chart 9 HYPOKALAEMIA Page 11

- **Hypoglycaemia?**
  - No
  - Yes
    - Go to flow chart 10 HYPOGLYCAEMIA Page 12

- **Acidosis failing to improve?**
  - No
  - Yes
    - Go to flow chart 11 PERSISTING ACIDOSIS Page 12

- **Go to flow chart 7 ONGOING MANAGEMENT Page 9**
FLOW CHART 7 – ONGOING MANAGEMENT

From flow chart 6  
MONITORING & REVIEWS

Blood glucose fallen to <14mmol/L?

If the blood glucose rises out of control, or the pH level is not improving after 4-6 hours consult senior medical staff and re-evaluate (possible sepsis, insulin dosage errors, blocked or leaking lines, excessive urine loss, fluid calculation error or other conditions), and consider starting the whole protocol again.

If the blood ketone level is not falling within 6-8 hours then get senior help and advice and consider increasing the insulin infusion rate to 0.1 Units/kg/hour or greater.

NO

Return to flow chart 6  
MONITORING & REVIEWS  Page 8

Yes

If local policy is to maintain 0.1 Units/kg/hour insulin infusion rate or if a higher insulin infusion rate is thought necessary then change the fluid to contain 10% Glucose rather than 5% Glucose, in order to prevent hypoglycaemia when the higher rate is continued (use 500mL bags of 0.9% Sodium Chloride with 10% Glucose and 20mmol Potassium Chloride in 500mL).

Change the fluid to contain 5% Glucose
i.e. 0.9% Sodium Chloride + 5% Glucose + 20mmol Potassium Chloride in 500mL

Time / Date fluids changed to contain glucose:

hh:mm dd/mm/yyyy

Continue the insulin infusion at 0.05 Units/kg/hour
i.e. reduce the rate from 0.1 Units/kg/hour if this rate was required prior to this point

If at any time the blood glucose falls below 4mmol/L immediately follow flow chart 10
HYPOGLYCAEMIA  Page 12

Blood glucose fallen to <6mmol/L?

NO

Blood ketones fallen to <1mmol/L?

NO

Return to flow chart 6  
MONITORING & REVIEWS  Page 8

Yes

Change the fluid to contain 10% glucose
i.e. 0.9% Sodium Chloride + 10% Glucose + 20mmol Potassium Chloride in 500mL

Time / Date fluids changed to contain 10% glucose:

hh:mm dd/mm/yyyy

Consider switching from intravenous to subcutaneous insulin
Start rapid-acting subcutaneous insulin at least 30 minutes before stopping intravenous insulin.

Time / Date SC insulin started:

hh:mm dd/mm/yyyy

Time / Date IV insulin stopped:

hh:mm dd/mm/yyyy

Subcutaneous insulin should be started according to local protocols for the child with newly diagnosed diabetes, or the child should be started back onto their usual insulin regimen at an appropriate time (discuss with senior staff).

Ongoing education and management as per local guidelines.

If blood glucose and ketones are not controlled following switch to SC insulin, consider re-starting DKA pathway.

Could this episode of DKA have been prevented?  
(i.e. earlier presentation not managed correctly?)

Yes  
No

If YES then feedback appropriately such as completing incident form or contacting GP.

End of DKA Pathway

Chart completed by:  
GMC number:  
Signature:  
Time / Date:  

<table>
<thead>
<tr>
<th>Time since protocol start (hrs)</th>
<th>Date/time (hh:mm dd/mm/yyyy)</th>
<th>Blood glucose (mmol/L)</th>
<th>Blood ketones (mmol/L)</th>
<th>pH</th>
<th>Base Excess</th>
<th>Bicarbonate (mmol/L)</th>
<th>Sodium (mmol/L)</th>
<th>Corrected sodium (mmol/L)</th>
<th>Potassium (mmol/L)</th>
<th>Urea (mmol/L)</th>
<th>Fluid balance (±mL)</th>
<th>Initial</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>+2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Changes:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>+6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Changes:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>+10</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Changes:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>+14</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Changes:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>+18</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Changes:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>+22</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Changes:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>+26</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Changes:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>+30</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Changes:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>+34</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Changes:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>+38</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Changes:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>+42</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Changes:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

After entering data values at each timeslot record any changes made on the following line. Record your clinical review and detailed plans in the patient notes. Remember to initial after completing each timeslot entry.

Corrected sodium levels should typically rise as blood glucose levels fall during treatment. Corrected sodium levels may give an indication of the risk of cerebral oedema with a falling corrected sodium indicating an excess of free water and an increased risk of cerebral oedema. If corrected sodium levels fall during treatment, discuss with the consultant on call. See appendix 3, page 15.

\[ Na_{corr} = Na_{measured} + \left( \frac{Glucose-5.6}{3.5} \right) \]
FLOW CHART 8 – CEREBRAL OEDEMA

Patient Name:
Date of Birth:
Hospital / NHS Number:

Earlier signs of cerebral oedema:
- headache
- agitation or irritability
- unexpected fall in heart rate
- increased blood pressure

Later signs of cerebral oedema:
- deterioration in level of consciousness
- abnormalities of breathing pattern, for example respiratory pauses and/or drop in SaO₂
- oculomotor palsy
- abnormal posturing
- pupillary inequality or dilatation

Suspicion of cerebral oedema

Choose option most readily available

Hypertonic saline 2.7% or 3%
(2.5 - 5 mL/kg over 10-15 minutes)
Time / Date treatment started:

Mannitol 20%
(2.5 - 5 mL/kg over 10-15 minutes)
Time / Date treatment started:

The effect of mannitol should be apparent within 15 minutes and typically lasts for 120 minutes. If no improvement within 30 minutes dose may repeated (or hypertonic saline may be preferred)
- If mannitol given initially and there is no response within 15-30 minutes then hypertonic saline may also be given as the effect of mannitol and hypertonic saline may be additive
- Inform senior staff
- Restrict fluids:
  - ½ maintenance rates
  - Replace deficit over 72 hours, rather than 48 hours
- Seek specialist advice on further management, including which care setting would be best for the patient
- Do not intubate and ventilate until an experienced doctor is available
- Once the patient is stable, exclude other diagnoses by CT scan

Return to MAIN PROTOCOL section

Be aware that other intracerebral events may occur (thrombosis, haemorrhage or infarction) and present similarly, however treatment of suspected cerebral oedema should not be delayed pending imaging.

FLOW CHART 9 – HYPOKALAEMIA

Following resuscitation, commence potassium immediately in rehydration fluid unless anuria is suspected or there are peaked T waves on ECG
- If initial K⁺ level > upper limit of normal range, especially if biochemical evidence of renal impairment, temporarily omit KCl but re-check frequently (e.g. after 1-2 hours) and add KCl to IV fluids once the patient has passed urine or as soon as K⁺ level fallen to within upper limit of normal range
- There is always massive depletion of total body K⁺, although initial plasma levels may be low, normal, or even high. Levels in the blood will fall once insulin is commenced, therefore ensure that every 500mL bag of fluid contains 20mmol potassium chloride (40mmol/L)

From MAIN PROTOCOL section

Hypokalaemia
(K⁺ <3mmol/L)

Use a cardiac monitor and observe frequently for T wave changes
- Consider temporarily reducing insulin infusion rate
- Discuss urgently with PICU as a central line is needed for K⁺ solutions >40mmol/L

Return to MAIN PROTOCOL section

Chart completed by:

GMC number:
Signature:
Time / Date:
FLOW CHART 10 – HYPOGLYCAEMIA

Give a bolus of 2 mL/kg of 10% Glucose

Volume: [ ] ml
Started: [ ]/[/ ]/ [ ] [: ]

- Increase concentration of glucose in fluids to 10% if not already done
- Reduce insulin infusion rate to 0.05 Units/kg/hour if currently running at a faster rate
- If insulin infusion already running at 0.05 Units/kg/hour, consider temporarily reducing this for 1 hour

FLOW CHART 11 – PERSISTING ACIDOSIS

- Consideration should be given to calculating the anion gap
- The anion gap is typically 20-30mmol/L in a patient with ketoadicosis. An anion gap >35mmol/L may suggest concomitant lactic acidosis due to sepsis or poor perfusion and should prompt a review of the overall clinical picture
- It is not required for routine monitoring but may be helpful if the clinical picture or biochemistry is not improving

Anion gap = Sodium - (Chloride + Bicarbonate) = [ ] mmol/L

e.g. 130 - (95 + 10) = 25mmol/L

If acidosis is not correcting, consider the following:
- Insufficient insulin to switch off ketones
- Inadequate resuscitation
- Sepsis
- Salicylate or other prescription or recreational drugs

Once all these causes of acidosis have been excluded, and if ketones are falling gradually, then residual acidosis is likely to be due to hyperchloraemia. This can be left to resolve spontaneously, and does not require any treatment. Acidosis due to hyperchloraemia need not delay the transition to oral fluids and subcutaneous insulin. It needs differentiating from ongoing ketosis.

Chart completed by:
GMC number:
Signature:
Time / Date:
FLOW CHART 12 - HYPEROSMOLAR HYPERGLYCAEMIC STATE

Patient Name: 
Date of Birth: 
Hospital / NHS Number: 

Features which differentiate HHS from other hyperglycaemic states such as DKA are:
- Hypovolaemia
- Marked hyperglycaemia (≥35 mmol/L or more)
- No significant hyperketonaemia (<3 mmol/L) or acidosis (pH > 7.3, bicarbonate > 15 mmol/L)
- Osmolality usually ≥320 mosmol/kg or more
- Often altered consciousness

From MAIN PROTOCOL section:

Suspicion of Hyperosmolar Hyperglycaemic State (HHS)

Discuss with the responsible senior paediatrician – these children can be very difficult to manage.

Fluid therapy

The goal of initial fluid therapy is to expand the intravascular volume and restore normal renal perfusion. The rate of fluid replacement should be more rapid than is recommended for DKA.

Give an initial bolus of 20 mL/kg of 0.9% Saline

Volume: 
Started: hh:mm dd/mm/yyyy

Additional fluid boluses should be given, if necessary, to restore peripheral perfusion.

Volume: 
Started: hh:mm dd/mm/yyyy

Thereafter, 0.45–0.75% Saline with potassium should be administered to replace the deficit over 24–48 hours. Assume a fluid deficit of approximately 12–15% of body weight.

Rate: 
Started: hh:mm dd/mm/yyyy

Further management considerations:
- If there is a continued rapid fall in serum glucose (>5 mmol/L per hour) after the first few hours, consider adding 2.5 or 5% Glucose to the rehydration fluid. Failure of the expected decrease of plasma glucose concentration should prompt reassessment and evaluation of renal function.
- Unlike treatment of DKA, replacement of urinary losses is recommended. The typical urine sodium concentration during an osmotic diuresis approximates 0.45% Saline; however, when there is concern about the adequacy of circulatory volume, urinary losses may be replaced with a fluid containing a higher sodium concentration.
- Insulin therapy
  - Blood glucose levels will fall with fluid alone and insulin is NOT required early in treatment.
  - Insulin administration should be initiated when serum glucose concentration is no longer declining at a rate of at least 3 mmol/L per hour with fluid administration alone.
- Potassium
  - Patients with HHS also have extreme potassium deficits; a rapid insulin-induced shift of potassium to the intracellular space can trigger arrhythmias. Therefore potassium MUST be included in all fluids.

Return to MAIN PROTOCOL section

Chart completed by: 
GMC number: 
Signature: 
Time / Date: 

[Diagram with steps and details]
APPENDIX 1 – GLASGOW COMA SCORE

Best Motor Response

1 = none
2 = extensor response to pain
3 = abnormal flexion to pain
4 = withdraws from pain
5 = localises pain
6 = responds to commands

Eye Opening

1 = none
2 = to pain
3 = to speech
4 = spontaneous

Best Verbal Response (with modification for younger patients)

>5 years 2-5 years <2 years

1 = none 1 = none 1 = none
2 = incomprehensible sounds 2 = grunts 2 = grunts
3 = inappropriate words 3 = cries or screams 3 = inappropriate crying or unstimulated screaming
4 = appropriate words but confused 4 = monosyllables 4 = cries only
5 = fully orientated 5 = words of any sort 5 = appropriate non-verbal responses (coos, smiles, cries)

APPENDIX 2 – ESTIMATED WEIGHT TABLE

<table>
<thead>
<tr>
<th>Age</th>
<th>Guide weight (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male</td>
</tr>
<tr>
<td>6 months</td>
<td>8</td>
</tr>
<tr>
<td>12 months</td>
<td>9.5</td>
</tr>
<tr>
<td>18 months</td>
<td>11</td>
</tr>
<tr>
<td>2 years</td>
<td>12</td>
</tr>
<tr>
<td>3 years</td>
<td>14</td>
</tr>
<tr>
<td>4 years</td>
<td>16</td>
</tr>
<tr>
<td>5 years</td>
<td>18</td>
</tr>
<tr>
<td>6 years</td>
<td>21</td>
</tr>
<tr>
<td>7 years</td>
<td>23</td>
</tr>
<tr>
<td>8 years</td>
<td>25</td>
</tr>
<tr>
<td>9 years</td>
<td>28</td>
</tr>
<tr>
<td>10 years</td>
<td>31</td>
</tr>
<tr>
<td>11 years</td>
<td>35</td>
</tr>
<tr>
<td>12 years</td>
<td>43</td>
</tr>
<tr>
<td>14 years</td>
<td>50</td>
</tr>
<tr>
<td>Adult</td>
<td>70</td>
</tr>
</tbody>
</table>

Adapted from Advanced Paediatric Life Support, version 6, 2016
APPENDIX 3 – MAKING UP IV FLUIDS

The following fluids are generally available from Pharmacy. They may not be available on every ward. If you need to make it up, please do so as below, rather than waiting for pharmacy.

0.9% Sodium Chloride with 5% Glucose and 20mmol Potassium Chloride in 500mL

1. Remove 50mL from a bag of Sodium Chloride 0.9% with 20mmol Potassium Chloride in 500mL
2. Draw up 50mL of Glucose 50% using a syringe and add to the above bag to make the glucose concentration 5%
3. Mix well before administration

0.9% Sodium Chloride with 10% Glucose and 20mmol Potassium Chloride in 500mL

1. Remove 100mL from a bag of Sodium Chloride 0.9% with 20mmol Potassium Chloride in 500mL
2. Draw up 100mL of Glucose 50% using a syringe and add to the above bag to make the glucose concentration 10%
3. Mix well before administration

Plasmalyte does not contain enough potassium to be used on its own; discuss with pharmacy/PICU before using as maintenance fluid to ensure adequate potassium replacement is provided.

APPENDIX 4 – EXPLANATORY NOTES

Sodium and Corrected Sodium ($Na_{corr}$)

Hyponatraemia occurs in DKA as with hyperglycaemia the extracellular osmolality rises resulting in water movement from the intracellular space into extracellular space causing dilution of extracellular sodium and a low serum sodium. However, when glucose begins to fall through hydration and insulin, and the plasma glucose concentration is reduced, water leaves the extracellular space entering intracellular space raising the extracellular sodium concentration again and the serum sodium typically rises. Corrected sodium levels give an indication of the amount of free water in the circulation.

Corrected sodium levels should typically rise as blood glucose levels fall during treatment. It has been suggested that corrected sodium levels give an indication of the risk of cerebral oedema with a falling corrected sodium indicating an excess of free water and an increased risk of cerebral oedema.

If corrected sodium levels fall during treatment, discuss with the consultant on call.

The formula for corrected sodium is:

$$Na_{corr} = Na_{measured} + \left(\frac{Glucose - 5.6}{3.5}\right)$$

For worked examples, refer to the full guideline (https://www.bsped.org.uk/clinical-resources/guidelines/).

Hyperchloraemic metabolic acidosis

Hyperchloraemic metabolic acidosis may occur following the administration of large amounts of chloride containing fluids given during the management of DKA. The preferential renal excretion of ketones instead of chloride can result in hyperchloraemia. The acidifying effect of chloride can mask the resolution of ketoacidosis if base deficit alone is used to monitor progress as there may appear to be a continuing base deficit with a continued low bicarbonate due to the chloride component rather than due to ketosis. Direct monitoring of ketones and calculation of the component of the base deficit due to chloride will help differentiate whether persisting acidosis is due to ongoing ketosis that may need additional treatment (adjustment to insulin infusion or fluids) or due to hyperchloraemia. Acidosis due to hyperchloraemia will correct spontaneously and doesn’t need specific treatment. Acidosis due to hyperchloraemia need not delay the transition to oral fluids and subcutaneous insulin. It needs differentiating from ongoing ketosis.
The formula for calculating the component of the base excess due to chloride is:

\[
BE_{\text{due to chloride}} = (\text{Sodium} - \text{Chloride}) - 32
\]

For worked examples, refer to the full guideline (https://www.bsped.org.uk/clinical-resources/guidelines/).

**Albumin**
A low serum albumin can also contribute to a persisting acidosis which may be erroneously attributed to persisting ketosis. Some intensivists also recommend partitioning the component of apparent acidosis due to the reduced albumin to avoid it being inappropriately attributed to persisting ketosis.

The formula for calculating the component of the base excess due to albumin is:

\[
BE_{\text{due to albumin}} = 0.25 \times (42 - \text{Albumin})
\]

**Bicarbonate**
Do not give intravenous sodium bicarbonate to children and young people with DKA. Only consider bicarbonate if there is life threatening hyperkalaemia or in severe acidosis with impaired myocardial contractility. It is anticipated that this would only ever be done following discussion with an intensivist.

**Risk of venous thrombosis**
Be aware that there is a significant risk of femoral vein thrombosis in young and very sick children with DKA who have femoral lines inserted. Lines should be in situ as short a time as possible. Thromboembolic prophylaxis should be considered in young people >16 years (in line with NICE guidance), in young women taking the combined oral contraceptive pill and sick patients with femoral lines, following discussion with an intensivist.

**Oral fluids**
Do not give oral fluids to a child or young person who is receiving intravenous fluids for DKA until ketosis is resolving and there is no nausea or vomiting.

A nasogastric tube may be necessary in the case of gastric paresis.

If oral fluids are given before the 48 hour rehydration period is completed, the IV infusion needs to be reduced to take account of the oral intake.

**Fluid losses**
Do not give additional intravenous fluid to replace urinary losses. Urinary catheterisation should be avoided but may be useful in the child with impaired consciousness.

If a massive diuresis continues for several hours fluid input may need to be increased; this should be isotonic to the urine. If large volumes of gastric aspirate continue, these will need to be replaced with 0.45% saline with Potassium Chloride.

**Other complications**
Other associations with DKA require specific management:

Continuing abdominal pain is common and may be due to liver swelling, gastritis, bladder retention, ileus. However, beware of appendicitis and ask for a surgical opinion once DKA is stable. A raised amylase is common in DKA.

Other problems are pneumothorax ± pneumo-mediastinum, interstitial pulmonary oedema, unusual infections (e.g. TB, fungal infections), hyperosmolar hyperglycaemic non–ketotic coma, ketosis in type 2 diabetes.

Discuss these with the consultant on-call.

END OF INTEGRATED CARE PATHWAY