British Society for Paediatric Endocrinology and Diabetes

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

Name

Date of Birth

Hospital / NHS Number

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 2021 guideline on which it is based which can be found at: https://www.bsped.org.uk/clinical-resources/bsped-dka-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.

dka-calculator.co.uk

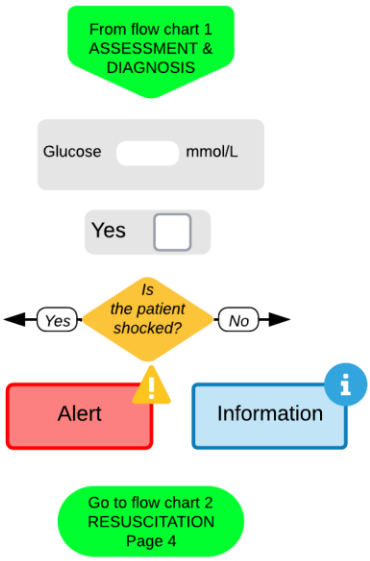
This ICP is designed in conjunction with an online calculator that will pre-fill elements, for example patient demographics and fluid calculations. While the ICP can be used without this step, use of the calculator is strongly advised as it reduces the risk of calculation errors. The calculator is also 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.

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

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.

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

COMPLICATIONS SECTION

APPENDICIES SECTION

FLOW CHART 1 – ASSESSMENT & DIAGNOSIS

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

START HERE

Suspect DKA

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

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

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

Ask for senior support

Check:
Blood Glucose
Blood Ketones
Blood Gas

Record initial values:

Glucose _____ mmol/L

pH _____

Ketones _____ mmol/L

Bicarb. _____ mmol/L

Raised blood glucose, pH >7.3 AND bicarbonate >15mmol/L → Consider new diabetes not in DKA Use local guidelines

Very high blood glucose (>33.3mmol/L), No significant ketosis (<3mmol/L) OR acidosis (pH>7.3, bicarb. >15mmol/L) → Go to flow chart 13 HYPEROSMOLAR HYPERGLYCAEMIC STATE Page 14

pH <7.3 or bicarbonate <15mmol/L AND Blood ketones >3mmol/L → **Diagnose DKA**

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.

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
- SpO_2 _____ %
- Acidotic pattern? Yes ☐ No ☐

Circulation
- HR _____ /min
- CRT _____ secs
- BP _____ /
- Clinically shocked? Yes ☐ No ☐

See also page 4

Disability
- GCS _____ /15
- M: _____ /6 V: _____ /5 E: _____ /4

See also appendix 1 page 15

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 flow chart 2 RESUSCITATION Page 4

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

FLOW CHART 2 – RESUSCITATION

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

From flow chart 1 ASSESSMENT & DIAGNOSIS

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

B: Give O_2 100% 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).

Recommended bloods:
- Blood ketones
- Blood gas
- $HbA1_c$
- FBC, U+Es, CRP
- Lab glucose

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

For estimated weight:
- Refer to appendix 2, page 15
- Ensure an accurate weight is obtained before starting maintenance fluids

Weight: _____ kg

Actual / Estimated / Recent

Is the patient shocked?

- Tachycardia
- Prolonged central capillary refill
- Poor peripheral pulses
- Hypotension (late sign)

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

Yes

Shocked patients: 10 ml/kg bolus of 0.9% saline or plasmalyte over 15 minutes

Volume: _____ ml

Started: hh:mm dd/mm/yyyy

Reassess: if still shocked further boluses of 10ml/kg (up to total of 40ml/kg) may be given

Volume: _____ ml hh:mm dd/mm/yyyy

Volume: _____ ml hh:mm dd/mm/yyyy

Volume: _____ ml hh:mm 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 10ml/kg bolus of 0.9% saline over 30 minutes

Volume: _____ ml

Started: hh:mm 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 17, for more information.

Consider placing NG tube to reduce the risk of aspiration in patients with reduced conscious level

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, oculomotor palsies, abnormal posturing, pupil inequalities or dilatation

Features of cerebral oedema?

No → Go to flow chart 3 SECONDARY REVIEW Page 5

Yes → Go to flow chart 9 CEREBRAL OEDEMA Page 12

Chart completed by: _____

GMC number: _____

Signature: _____

Time / Date: _____

FLOW CHART 3 – SECONDARY REVIEW

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

From flow chart 2
RESUSCITATION

History:

Consider features including:
- Polyuria/polydipsia/wetting
- Weight loss
- Vomiting/abdominal pain
- Headache
- Recent infection

Past medical history:

If pre-existing diabetes ask about previous DKA episodes.

Drug history:

If pre-existing diabetes include usual insulin regimen details, adherence.

Allergies:

Family and social history:

Ask about family history of diabetes, thyroid disease, coeliac disease and other auto-immune conditions.

Examination:

Including general status, cardiovascular, abdomen, respiratory/ENT, neurology... Consider signs as shown on ASSESSMENT & DIAGNOSIS flow chart 1

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.

Go to flow chart 4
FLUIDS
Page 6

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

FLOW CHART 4 - FLUIDS

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

From flow chart 3 SECONDARY REVIEW

To avoid excessive amounts of fluid in overweight and obese children it is recommended that consideration be given to using a **maximum weight of 75kg 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.

Decide DKA severity

- pH <7.1 and/or bicarb. <5 SEVERE DKA → Assume 10% dehydration
- pH 7.1-7.19 and/or bicarb. <10 MODERATE DKA → Assume 5% dehydration
- pH 7.2-7.29 and/or bicarb. <15 MILD DKA → Assume 5% dehydration

Fluid calculations

Fluid deficit = Patient weight kg × % Dehydration × 10 = _____ mL

e.g. 24kg × 5% × 10 = 1200mL

Subtract ONLY the 10mL/kg bolus given over 30 minutes to non-shocked patients. DO NOT subtract rapid resuscitation boluses given to shocked patients.

Fluid deficit (less bolus volume) = Fluid deficit mL − 10ml/kg bolus volume mL = _____ mL

e.g. 1200mL − 240mL = 960mL

Deficit replacement rate = Fluid deficit (less bolus volume) mL ÷ 48 hours = _____ mL/hour

e.g. 960mL ÷ 48hours = 20.0mL/hour

Use Holliday-Segar formula: i.e. 100mL/kg for first 10kg; 50mL/kg for next 10kg; 20mL/kg thereafter.

Note: deficit is replaced over 48 hours, maintenance rate is calculated over 24 hours.

Maintenance rate = Daily fluid requirement mL ÷ 24 hours = _____ mL/hour

e.g.(for 24kg) (1000mL+500mL+80mL) ÷ 24hours = 65.8mL/hour

STARTING FLUID RATE (after bolus complete) = Maintenance rate mL/hour + Deficit replacement rate mL/hour = _____ mL/hour

e.g. 65.8mL/hour + 20.0mL/hour = 85.8mL/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: hh:mm dd/mm/yyyy

Go to flow chart 5 INSULIN Page 7

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

FLOW CHART 5 - INSULIN

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

From flow chart 4 FLUIDS

Starting insulin early may increase the risk of cerebral oedema

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

If potassium <3.0mmol/L defer insulin until potassium >3.0mmol/L. If expected to cause significant delay discuss with intensivist regarding options including central access or oral potassium.

Insulin hourly rate = [0.05-0.1] Units/kg /hour × [Patient weight] kg = [ ] Units /hour

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

Starting insulin rates of 0.05 and 0.1 Units/kg/hr are typically suggested. A rate of 0.05 Units/kg/hr should be used in most cases unless your local policy dictates otherwise, or in specific cases (such as in adolescents or severe DKA) as directed by a senior paediatrician or intensivist.

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 ☐ 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 MONTORING & REVIEWS Page 8

Chart completed by: _____

GMC number: _____

Signature: _____

Time / Date: _____

FLOW CHART 6 – MONITORING & REVIEWS

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

From flow chart 5 INSULIN

From flow chart 7 ONGOING MANAGEMENT

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.

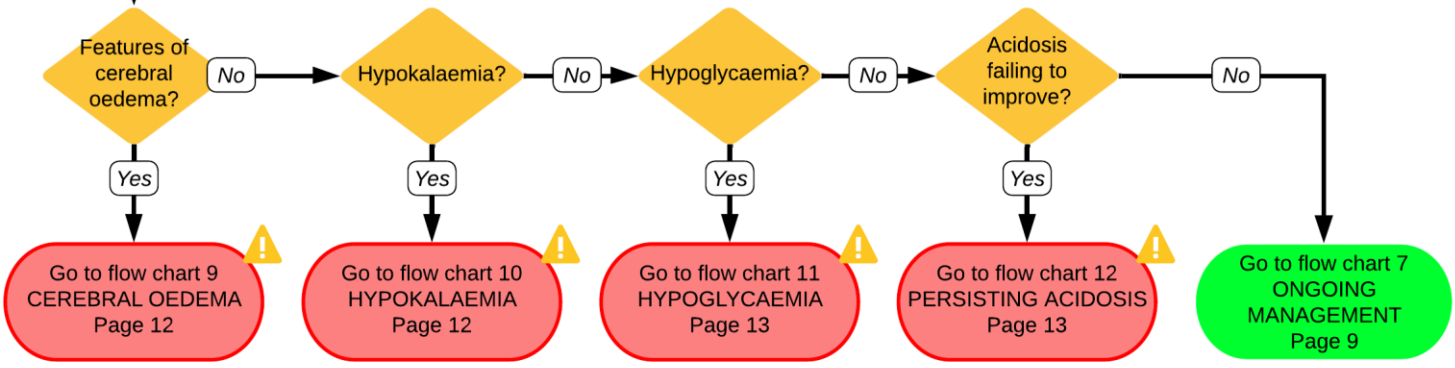
N.B. Where PICU or HDU do not exist within the admitting hospital, transfer to another hospital may not be appropriate (unless ventilatory support becomes necessary).

However, ALL children with DKA are high-dependency patients and require a high level of nursing care.

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 11):
  - Glucose (Laboratory measurement)
  - Blood gas (for pH and pCO_2)
  - 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 16) 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.



FLOW CHART 7 – ONGOING MANAGEMENT

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

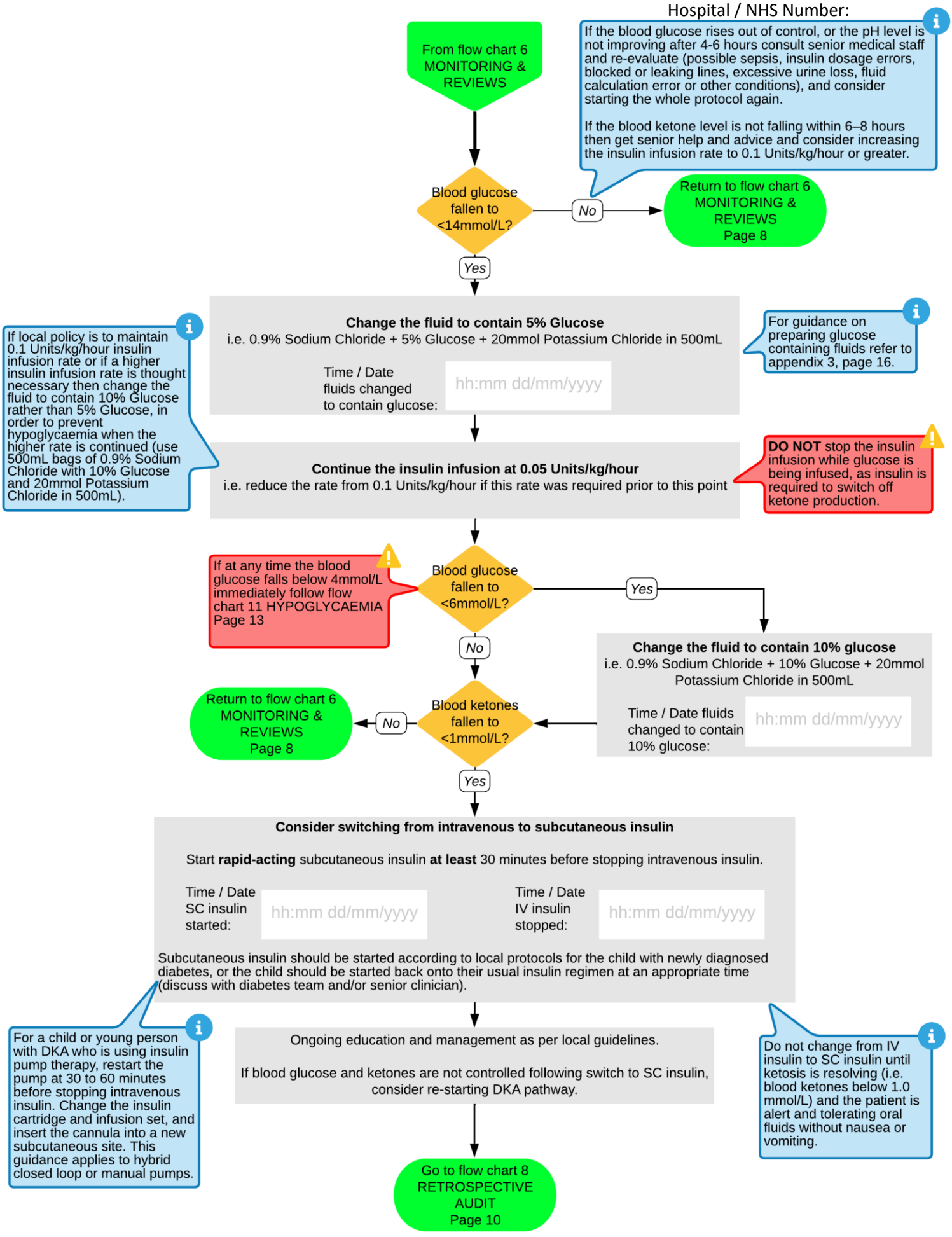


Chart completed by: _____

GMC number: _____

Signature: _____

Time / Date: _____

FLOW CHART 8 – RETROSPECTIVE AUDIT

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

From flow chart 7 ONGOING MANAGEMENT

Were there any preventable factors which may have contributed to this episode of DKA?

Yes

No

Some relevant factors to consider: (tick if relevant)

- Missed/delayed diagnosis
  - Lack of or delayed access to primary care appointment ☐
  - Missed or delayed diagnosis in primary care ☐
  - Suboptimal or incorrect investigation/referral by primary care ☐
  - Missed or delayed diagnosis in secondary/tertiary care ☐
  - Suboptimal or incorrect management by secondary/tertiary care ☐
  - Other diagnosis issue ☐
- Diabetes technology issue
  - Concern of insulin pump malfunction ☐
  - Concern insulin pump used incorrectly ☐
  - Concern of glucose sensor malfunction ☐
  - Other technology issue ☐
- Lack of adherence
  - Concern insulin pump used incorrectly ☐
  - Concern of inadequate supervision by parent/carer ☐
  - Concern of lack of adherence to usual insulin therapy by child/young person ☐
  - Suboptimal monitoring of glucose or ketones ☐
  - Sick day rules not followed optimally ☐
  - Other adherance issue ☐
- Social factors
  - Concern of inadequate supervision by parent/carer ☐
  - Language barrier ☐
  - Other social factor ☐

Consider if any patient level or system level actions are required.

Encourage your team to use the DKA Calculator next time where preventable factors and other retrospective data for your patient group can be monitored.

End of DKA Pathway

Chart completed by: _____

GMC number: _____

Signature: _____

Time / Date: _____

Patient Name:

Date of Birth:

Hospital / NHS Number:

TABLE 1 - SERIAL DATA SHEET

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

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 4, page 16.

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

Or, use the corrected sodium / effective osmolality calculator
dka-calculator.co.uk/sodium-osmo

FLOW CHART 9 – CEREBRAL OEDEMA

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

From MAIN PROTOCOL section

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

Suspicion of cerebral oedema

Later signs of cerebral oedema:
- deterioration in level of consciousness
- abnormalities of breathing pattern, for example respiratory pauses and/or drop in SaO_2
- oculomotor palsies
- abnormal posturing
- pupillary inequality or dilatation

Choose option most readily available

Hypertonic saline 2.7% or 3%
(2.5 - 5 mL/kg over 10-15 minutes)

Time / Date treatment started: hh:mm dd/mm/yyyy

- 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

Mannitol 20%
(2.5 - 5 mL/kg over 10-15 minutes)

Time / Date treatment started: hh:mm dd/mm/yyyy

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.

- 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

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

FLOW CHART 10 – HYPOKALAEMIA

From MAIN PROTOCOL section

- 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**)

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

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

FLOW CHART 11 – HYPOGLYCAEMIA

From MAIN PROTOCOL section

Hypoglycaemia (Blood glucose <4mmol/L)

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

Volume: _____ ml

Started: dd/mm/yy hh:mm

- 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

Return to MAIN PROTOCOL section

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

FLOW CHART 12 – PERSISTING ACIDOSIS

From MAIN PROTOCOL section

- Consideration should be given to calculating the anion gap
- The anion gap is typically 20-30mmol/L in a patient with ketoacidosis. 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

Acidosis, ketones or clinical status not improving as expected

Check infusion lines, and the calculation and dose of insulin

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.

Return to MAIN PROTOCOL section

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

FLOW CHART 13 - HYPEROSMOLAR HYPERGLYCAEMIC STATE

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

From MAIN PROTOCOL section

Features which differentiate HHS from other hyperglycaemic states such as DKA are:
- Hypovolaemia
- Marked hyperglycaemia (33.3mmol/L or more)
- No significant hyperketonaemia (<3mmol/L) or acidosis (pH>7.3, bicarbonate >15mmol/L)
- Osmolality usually 320mosmol/kg or more
- Often altered consciousness

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 intra and extravascular 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: _____ mL

Started: hh:mm dd/mm/yyyy

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

Volume: _____ mL

Started: hh:mm dd/mm/yyyy

Volume: _____ mL

Started: hh:mm dd/mm/yyyy

- The goal is to promote a gradual decline in serum sodium concentration and osmolality
- As isotonic fluids are more effective in maintaining circulatory volume, isotonic saline should be restarted if perfusion and hemodynamic status appear inadequate as serum osmolality declines
- Serum sodium concentrations should be measured frequently and the sodium concentration in fluids adjusted to promote a gradual decline in corrected serum sodium concentration
- Mortality has been associated with failure of the corrected serum sodium concentration to decline with treatment, which may be an indication for haemodialysis
- Although there are no data to indicate an optimal rate of decline in serum sodium, 0.5mmol/L per hour has been recommended for hypernatraemic dehydration

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: _____ mL/hour

Started: hh:mm dd/mm/yyyy

Further management considerations:
- If there is a continued rapid fall in serum glucose (>5mmol/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 3mmol/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 an arrhythmia. Therefore potassium MUST be included in all fluids
- For further information see ISPAD Guidelines:

Return to MAIN PROTOCOL section

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

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

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

Age	Guide weight (kg)	
	Male	Female
6 months	8	7
12 months	9.5	9
18 months	11	10
2 years	12	12
3 years	14	14
4 years	16	16
5 years	18	18
6 years	21	20
7 years	23	22
8 years	25	25
9 years	28	28
10 years	31	32
11 years	35	35
12 years	43	43
14 years	50	50
Adult	70	70

Adapted from Advanced Paediatric Life Support, version 6, 2016

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

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 50mL from a bag of Sodium Chloride 0.9% with 5% Glucose and 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 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:

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

You can also use the corrected sodium / effective osmolality calculator available at https://dka-calculator.co.uk/sodium-osmo.

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

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

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

$$BE_{due\ to\ chloride} = (Sodium - Chloride) - 32$$

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

$$BE_{due\ to\ albumin} = 0.25 \times (42 - Albumin)$$

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