DIABETES ICP
Number: 1
Diabetic Ketoacidosis (DKA)

Insert ICP into a yellow diabetes folder (stored in A&E)

Every patient newly diagnosed with diabetes should receive a blood glucose meter kit and a copy of ‘Your Diabetes Handbook’ in A&E

☐ Please initial when supplied

☐ For newly diagnosed patient:
Insert ICP Number 3 at presentation into folder (and initial)

☐ For known patient in DKA:
Insert ICP Number 2 at presentation into folder (and initial)

For known diabetes patient:
Check that patient has brought their own insulin pens.
If no, ask to bring as soon as possible

☐ Yes
☐ No
Disclaimer for use on Printed Pathway

This Integrated Care Pathway was developed by the Diabetes Team, Royal Hospital for Sick Children, Edinburgh for the management of children with Type I Diabetes attending the Royal Hospital for Sick Children, Edinburgh. The Integrated Care Pathway does not provide all training required for individual personnel to be competent in the management of paediatric diabetes. The Integrated Care Pathway should be regarded as providing only one component of any recipient organisation’s own comprehensive training programme. Lothian Health Board uses reasonable endeavours to ensure the accuracy and reliability of the Integrated Care Pathway but no guarantees are made that the information contained in the Integrated Care Pathway is accurate, complete or current at any given time. Any information in the Integrated Care Pathway is used as general information and is not warranted by Lothian Health Board or any other health organisation, nor should it be taken as advice. No responsibility can be accepted by Lothian Health Board or any other health organisation for action or in-action as a result of information contained in the Integrated Care Pathway. Specific advice should be sought in specific situations from a suitably qualified expert.
1. Purpose of this document
To ensure that all staff have clear guidance to follow when a child or young person up to 16 years of age presents in diabetic ketoacidosis (either newly diagnosed patient or patient with known diabetes).

2. Who should use this document
All medical and nursing staff, and professionals allied to medicine within Children’s Services.

3. To whom this document applies
All medical and nursing staff, and professionals allied to medicine within Children’s Services.

4. Contact point
Dr Kathryn Noyes, Associate Specialist – Paediatric Diabetes
Dr Louise Bath, Lead Consultant in Paediatric and Adolescent Diabetes
Dr Harriet Miles, Consultant in Paediatric and Adolescent Diabetes
Mrs. Marion Henderson, Senior Secretary, Diabetes Team
Diabetes Team Members

5. Further reference
International Society of Paediatric and Adolescent Diabetes (ISPAD) Clinical Practice Consensus Guidelines 2014 Compendium:
Diabetic Ketoacidosis and hyperglycaemic hyperosmolar state.
Pediatric Diabetes 2014: 15 (Suppl.20): 154-179
doi:10.1111/pedi.12165
Also available at www.ispad.org (under guidelines)
BSPED Recommended DKA Guidelines 2009 (minor review 2013):
www.bsped.org.uk/clinical/docs/DKAGuideline.pdf

Review group
Dr Kathryn Noyes, Associate Specialist – Paediatric Diabetes
Dr Louise Bath, Lead Consultant in Paediatric and Adolescent Diabetes
Dr Sarah Kiff, Paediatric Speciality Registrar
Dr Omair Malik, PICU Speciality Doctor
Diabetes Team Members
Katy Currie, Charge Nurse A+E
Angela Holmes, Charge Nurse HDU/ITU
Kirsten Thomson, Senior Pharmacist

Review date: January 2018
Royal Hospital for Sick Children Edinburgh

Diabetic Ketoacidosis Integrated Care Pathway Flowchart

1. Confirm the diagnosis – immediate capillary blood sample (p9)
   - POCT glucose usually >11mmol/l plus
   - Blood gas pH <7.3 and/or
   - Standard bicarbonate <15mmol/l and/or impaired consciousness plus
   - POCT blood ketones >3mmol/l
   - Inform Senior Dr on call

2. Initial Assessment + Resuscitation (p8)
   - Fluid resuscitation only if shocked (p8) to restore peripheral circulation
   - Nil by mouth

3. Proceed with presenting history and clinical examination of child
   - For children on pump therapy stop the pump when starting DKA treatment.

4. IV Fluid Management to commence in A&E (p16)
   - Commence 0.9% sodium chloride within 1 hour of admission

5. Observe closely for signs of cerebral oedema (p31)
   - If suspected, initiate treatment immediately.

6. Admit to HDU (to start insulin infusion) within 2 hours of presentation
   - Start IV insulin infusion 1-2 hours after starting fluid replacement therapy (p21)
   - Management of insulin infusion (p25-26)
   - Hourly POCT glucose and ketones

7. Junior Medical Staff Actions
   - 2-4 hourly Na, K, Urea + glucose to lab
   - Maintain plasma K 4-5mmol/l (p22)
   - Watch for falling plasma Na (p23)
   - 2-4 hourly venous blood gas until pH > 7.3 (p28)

8. End Point for IV Insulin Therapy
   - Continue IV insulin infusion until pH > 7.3 and 2 consecutive POCT ketone readings thereafter are <1.0mmol/l (p27)
   - Commence subcutaneous insulin regimen and transfer to Medical Ward – use appropriate follow-on pathways (ICP 2 or ICP 3)

POCT = Point Of Care Testing, i.e. using test strip + hand-held meter. Glucose POCT may be inaccurate with severe dehydration/acidosis. Check with a venous lab glucose.

Too rapid rehydration may cause cerebral oedema with significant risk of mortality/morbidity.
All staff using this pathway must complete this section, before initialling completed care. This allows you to use only your initials throughout Pathway.

<table>
<thead>
<tr>
<th>DATE</th>
<th>PRINT NAME</th>
<th>INITIAL</th>
<th>DESIGNATION</th>
<th>SIGNATURE</th>
</tr>
</thead>
<tbody>
<tr>
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</tbody>
</table>

This document represents expected care for the patient. Staff using this pathway may need to modify treatment for individual patients, therefore use clinical and professional judgement. Any alteration to the care outlined in this pathway must be recorded as a ‘variation’.
Insert and complete age appropriate PEWS (Paediatric Early Warning Scores) chart
Integrated Care Pathway: Diabetic Ketoacidosis

DATE: WARD:
Affix ID label or complete
PATIENT NAME:
UNIT NO.:
D.O.B.:

INITIAL ASSESSMENT AND RESUSCITATION

Date: Patient presented to A&E at: hours

TICK TO CONFIRM EACH ACTION

Insert and complete age appropriate PEWS (Paediatric Early Warning Scores) chart: 

1. Airway
   Ensure airway is patent If child comatose, insert an airway
   If vomiting or drowsy pass NG tube Aspirate and leave on open drainage
   Commence Omeprazole if aspirate positive for blood
   If using via NG tube consider Ranitidine as an alternative

2. Breathing
   Give 100% oxygen by face mask, if required

3. Circulation
   Insert iv cannula(e) and take blood samples (see p9)
   Cardiac monitor for T waves (peaked in hyperkalemia)
   FLUID RESUSCITATION ONLY IF SHOCKED:
   (only expect in severe DKA: venous pH < 7.1 or bicarbonate < 5mmol/L)
   • Poor peripheral pulses
   • Poor capillary filling with tachycardia
   • And/or hypotension
   ACTION: Volume expansion with 0.9% sodium chloride 10ml/kg over 1hr

Actual Weight: Kg or Estimated Weight: Kg

<table>
<thead>
<tr>
<th>Volume to be infused (10 x weight)</th>
<th>mls</th>
<th>mls</th>
<th>mls</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time Commenced</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Time Completed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prescribe on Fluid Chart (p42)</td>
<td>INITIAL:</td>
<td>INITIAL:</td>
<td>INITIAL:</td>
</tr>
</tbody>
</table>

Repeat if necessary until circulation restored to a maximum of 30ml/kg.
Discuss with a Consultant if the child has already received 30ml/kg.
Integrated Care Pathway: Diabetic Ketoacidosis

4. Disability (neurology)

Pupillary reaction to light normal.

Right: Yes ☐ No ☐

Left: Yes ☐ No ☐

AVPU (please circle)

Alert Voice Pain Unresponsive

5. POCT Results

<table>
<thead>
<tr>
<th>POCT Blood Tests</th>
<th>Time 0:</th>
<th>Time+1hr:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glucose</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ketones</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blood Gas</td>
<td>Time 0:</td>
<td>Time+1hr:</td>
</tr>
<tr>
<td>pH</td>
<td></td>
<td></td>
</tr>
<tr>
<td>pCO₂</td>
<td></td>
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<tr>
<td>HCO₃</td>
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</tr>
</tbody>
</table>

| Urinalysis       | Ketones:| Glucose:| Protein:| Blood:|

Severity of DKA is categorized by degree of acidosis

☐ 1. Mild: Venous pH <7.3 or bicarbonate <15mmol/L

☐ 2. Moderate: Venous pH <7.2 or bicarbonate <10mmol/L

☐ 3. Severe: Venous pH <7.1 or bicarbonate <5mmol/L

6. Blood test to be sent to the lab

Initial blood tests to be taken in A+E: 4 ml blood required

USE DKA ORDER FORM on TRAK. Record results on p33.
(Diabetes order sets: new diabetes admission paediatric diabetes RHSC)

2ml Li Hep 1ml plain 0.5ml flox 0.5ml EDTA

DKA MAY BE PRECIPITATED BY SEPSIS AND FEVER IS NOT PART OF DKA

A raised WCC and a raised amylase are common in DKA but do not confirm sepsis/acute abdominal pathology. Take blood for blood cultures if febrile. Antibiotics are not given as routine unless a bacterial infection is suspected. Continuing abdominal pain is common and may be due to liver swelling, gastritis, bladder retention and ileus.
## Initial Assessment and Resuscitation

For those Patients Transferred/Retrieved -

Summary of Treatment received prior to presentation at R.H.S.C.

Insert Retrieval Document if available.

<table>
<thead>
<tr>
<th>DATE</th>
<th>WARD</th>
<th>D.O.B.</th>
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</table>
### Integrated Care Pathway: Diabetic Ketoacidosis

**DATE:** _______________________  
**WARD:** _______________________  
**PATIENT NAME:** _______________________  
**UNIT NO.:** _______________________  
**D.O.B.:** _______________________

**MEDICAL CLERKING AND MANAGEMENT (TO BE COMPLETED IN A+E)**

#### Presenting History (Tick if Yes)

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Duration</th>
<th>Polyuria</th>
<th>AMOUNT</th>
<th>Kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polydipsia</td>
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<tr>
<td>Nocturnal Enuresis</td>
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</tr>
<tr>
<td>Weight Loss</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Lethargy</td>
<td></td>
<td></td>
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<tr>
<td>Mood Changes</td>
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</tr>
<tr>
<td>Abdominal Pain</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Vomiting</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Intercurrent Illness</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Visual Disturbance</td>
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<td></td>
</tr>
<tr>
<td>Perineal/Oral thrush</td>
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</tbody>
</table>

**For further comments during initial clerking and assessment**

Please include contact with GP, contact with NHS 24 and contact with RHSC Diabetes Emergency Helpline

---

**Royal Hospital for Sick Children Edinburgh**

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Integrated Care Pathway: Diabetic Ketoacidosis

Affix ID label or complete

PATIENT NAME:

UNIT NO.:

DATE: WARD: D.O.B.:

Systemic Enquiry

CVS

RS

GIS

GUS

CNS

Known Type 1 Diabetes

Date of Diagnosis: [] Time of last Insulin Dose:

Last Known HbA1c: mmol/mol Name of Insulin Given:

Date of Last Known HbA1c: Date of Last Known HbA1c:

Dose of Insulin Given: Units

Current Insulin Regimen

<table>
<thead>
<tr>
<th>Time/Meal</th>
<th>Type of Insulin &amp; Pen Device (disposable/cartridges)</th>
<th>Ratios Insulin (units): Carbs (g)</th>
<th>Usual Dose</th>
<th>Correction for High BG</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
<td></td>
<td>Correction Factor (1unit lowers xmmol/l)</td>
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<tr>
<td></td>
<td></td>
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<td></td>
<td>BG 10-15</td>
</tr>
</tbody>
</table>

Insulin Pump Therapy: [] Type of insulin: 

Time disconnected from pump: 

MEDICAL CLERKING AND MANAGEMENT (TO BE COMPLETED IN A+E)
Integrated Care Pathway: Diabetic Ketoacidosis

DATE: WARD: 
Affix ID label or complete
PATIENT NAME: 
UNIT NO.: D.O.B.: 

MEDICAL CLERKING CONTINUED

Birth and Development

Immunisation

Complete □ Incomplete □ Comment:

Past Medical History

Current Medication:
□ Medicines reconciliation - Print off Emergency Care Summary (ECS) & insert here
□ Confirm with carer
□ Medicines reconciliation initiated & issues identified

Allergies

Family History

<table>
<thead>
<tr>
<th></th>
<th>Type 1 Diabetes</th>
<th>Date of Diagnosis</th>
<th>Thyroid Disease</th>
<th>Coeliac</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mother</td>
<td></td>
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<tr>
<td>Father</td>
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<tr>
<td>Sibling</td>
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<td>Sibling</td>
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</table>
### Clinical Examination at Presentation

<table>
<thead>
<tr>
<th>ENT</th>
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<tbody>
<tr>
<td>CVS</td>
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<tr>
<td>RS</td>
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<td>GIS</td>
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<tr>
<td>CNS</td>
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Injection sites for patients with known diabetes (indicate areas of lipohypertrophy):
**Integrated Care Pathway: Diabetic Ketoacidosis**

**DATE: WARD: TAKEN BY:**

**PATIENT NAME:**

**UNIT NO.:**

**D.O.B.:**

---

**FLUID MANAGEMENT: TO COMMENCE IN A&E**

**FLUID REQUIREMENT = MAINTENANCE + DEFICIT**  Use 0.9% Sodium Chloride

**Fluids** (Document all fluids carefully)

### 1. MAINTENANCE

The rate of IV fluid should be calculated to rehydrate evenly over at least 48 hours.

<table>
<thead>
<tr>
<th>Body Weight</th>
<th>Fluid Requirement per 24hr (ml/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st 10kg</td>
<td>100</td>
</tr>
<tr>
<td>2nd 10kg</td>
<td>50</td>
</tr>
<tr>
<td>Subsequent kg</td>
<td>20</td>
</tr>
</tbody>
</table>

**SHOW CALCULATIONS** for 24 hour maintenance requirement

**24hr Maintenance = ml**

**48hr Maintenance = (2x24hr) ml**

### 2. DEFICIT

Clinical estimates of volume deficit typically overestimate the deficit. Therefore correct for:

- □ 1. Mild (Venous pH <7.3 or bicarbonate <15mmol/L) DKA as 3% dehydrated
- □ 2. Moderate (Venous pH <7.2 or bicarbonate <10mmol/L) DKA as 6% dehydrated
- □ 3. Severe (Venous pH <7.1 or bicarbonate <5mmol/L) DKA as 8% dehydrated

**Deficit (in ml) = % dehydration × weight (in kg) × 10 = ml**
**Integrated Care Pathway: Diabetic Ketoacidosis**

**Final Hourly Infusion Rate (ml) for First 48 Hours**

\[(48 \text{ hour maintenance} + \text{deficit}) - \text{resuscitation fluid already given}\]

\[\frac{\text{total volume over 48hrs}}{48}\]

**STEP 1**

48 hour maintenance + deficit

**STEP 2**

48 hour maintenance + deficit - resuscitation fluid already given

**STEP 3**

Total volume over 48hrs divided by 48

To prescribe potassium in fluids see p22.

**Calculated by:**

**Calculation checked by:**

**Prescribe on parenteral infusion prescription p42:**

**Commence 0.9% sodium chloride within 1 hour of admission:**

**I.V. fluids commenced:**

**Document on parenteral infusion prescription p42:**

**Prescribe insulin p21 and on parenteral infusion prescription p42:**

**Admit to HDU for insulin infusion within 2 hours of presentation:**

**Inform on-call consultant of admission to HDU:**
To be completed in full by H.D.U. Nursing Staff

Mother
NAME:  OCCUPATION:  TEL:  

Father
NAME:  OCCUPATION:  TEL:  

Siblings
NAME:  D.O.B.:  NAME:  D.O.B.:  
NAME:  D.O.B.:  NAME:  D.O.B.:  

Patient lives with:

Faith/Cultural Belief:  Ethnic Group:  

GP
NAME:  TEL:  
ADDRESS:  

School/Nursery
NAME:  TEL:  
ADDRESS:  

Admission to HDU
DATE:  TIME:  

Admission history

Referral:  GP  Self  NHS 24  Emergency Diabetes Helpline  Transfer from other Hospital  

On arrival to HDU
Actual Weight:  Kg  or  Estimated Weight:  Kg  
Weight documented in A&E:  Kg (see p8)  

Inform Diabetes Nurse Specialist of Child’s Admission (Extension 20375 — Answerphone)  INITIAL:  
Inform Dietitian of Child’s Admission (Extension 20302 — Answerphone)  INITIAL:  

Explanation of use of ICP with:  RELATIVE:  BY:  
### Integrated Care Pathway: Diabetic Ketoacidosis

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<th>Date:</th>
<th>Ward:</th>
<th>D.O.B.:</th>
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</thead>
</table>

**To be completed in full by H.D.U. Nursing Staff**

#### Contact with infectious diseases in last month

Yes [ ] No [ ] If Yes, give details:

#### Allergies

Yes [ ] No [ ] If Yes, give details:

#### Communication

**Speech:**

**Preferred language**

<table>
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<tr>
<th>Parent:</th>
<th>Child:</th>
</tr>
</thead>
</table>

**Eyesight:**

Normal [ ] Glasses [ ] Other [ ]

If other, give details:

**Hearing:**

Normal [ ] Hearing impaired [ ]

#### Sleep

**HOURS/NIGHT:**

**BEDTIME:**

#### Nutrition

Breast fed [ ] Vegetarian [ ] Halal [ ] Kosher [ ]

Other dietary requirements:

NG feeds:

Gastrostomy:

<table>
<thead>
<tr>
<th>Bottle</th>
<th>Feeder cup</th>
<th>Cup</th>
</tr>
</thead>
</table>

#### Elimination

Nappies [ ] Toilet training [ ] Toilet trained [ ]

#### Other/Social Services

Health Visitor [ ] Diabetes Nurse [ ] School Nurse [ ] Other [ ]

If other, give details:

#### Other information (if applicable)
MANAGEMENT IN HDU

Aim to correct metabolic abnormalities slowly: too rapid reversal may cause cerebral oedema with significant mortality/morbidity.

Expected nursing care

- Start IV insulin infusion 1-2 hours after starting fluid replacement therapy.
- Documentation of hourly fluid balance is of paramount importance.
- Hourly BP and basic observations.
- Immediate reporting of changes in neurological observations, including symptoms of headache, any change in behaviour or slowing of pulse rate.
- Immediate reporting of ECG trace changes: especially T wave changes suggesting hypo/hyperkalaemia.
- Hourly documentation of POCT blood glucose (p37).
- Hourly documentation of POCT blood ketone values (p37).
- Hourly review of IV insulin infusion rate (p37).
- Withhold oral fluids until pH $\geq 7.3$ (and bowel sounds present).

Expected medical care

- Documented medical review required at least 4 hourly p29 (check blood glucose falling as expected and conscious level normal - Appendix I).
- Check biochemistry, blood pH, and laboratory blood glucose 2 hours after the start of resuscitation, and then at least 4 hourly.
- Record all blood results (p33) and document any actions required.
- Review the fluid composition and rate according to each set of electrolyte results (p22 & 23).
- Review fluid balance: Urinary catheterisation should be avoided but may be useful in the child with impaired consciousness. If a massive diuresis continues, and the patient is in negative balance, fluid input may need to be increased.
- Review hourly IV insulin infusion rate and rate of fall of blood ketones.
INTRAVENTOUS INSULIN INFUSION

Remember: Insulin is essential to switch off ketogenesis and reverse the acidosis

- Transfer to HDU/ITU for insulin infusion to commence 1-2 hours after starting fluid replacement therapy. There is some evidence that cerebral oedema is more likely if insulin is started early.
- Monitor blood glucose HOURLY (by finger prick) whilst insulin infusion running.
- Monitor blood ketones HOURLY (by finger prick) whilst insulin infusion running.

**ACTION:** INSULIN PRESCRIPTION

1. Prescribe 50 units soluble insulin (Actrapid or Humulin S) added to 50ml 0.9% sodium chloride (a solution of 1 unit per ml).
2. Prescribe on parenteral infusion prescription (p42). State infusion rate ‘as per ICP’.
3. Calculate insulin infusion rate, as below.

\[
0.05 \text{ units insulin} \times \text{ weight (kg)/hour} = 0.05 \times \underline{\text{kg}} = \underline{\text{units/hr}}
\]

Note: units/hour also equals mls/hour

**ACTION:** INSULIN INFUSION

1. Start insulin infusion 1-2 hours after starting fluid replacement therapy.
2. Attach this using a Y-connector to the IV fluids already running.
3. Fluid replacement therapy commenced at: (see p17)

Insulin infusion commenced at:

SIGNATURE: __________________________  DATE:_________________  TIME:______________
ELECTROLYTE MANAGEMENT - POTASSIUM

Check U+E’s 2 hours after resuscitation is begun and then at least 4 hourly.

- There is always massive depletion of total body potassium, although initial plasma levels may be low, normal, or even high.
- Levels in the blood will fall once insulin is commenced.
- Maintain plasma potassium 4-5 mmol/l.
- Observe cardiac monitor for T wave changes.

**ACTION:**

Potassium

- >5mmol/L
  - Defer potassium replacement until urine output is documented.
  - Assess for ECG changes of hyperkalaemia.

- ≤5mmol/L
  - Add 20mmol potassium chloride/500ml 0.9% sodium chloride.
  - Start replacement after initial volume expansion + concurrent with starting insulin therapy.

Maintain plasma potassium 4-5 mmol/L using a maximum of 40mmol potassium chloride/500ml fluid if required

**Phosphate**

- There is always depletion of phosphate, another predominately intracellular ion.
- Plasma levels may be very low.
- There is no evidence in adults or children that replacement has any clinical benefit and phosphate administration may lead to hypocalcaemia.
- Severe hypophosphatemia should be treated if associated with either metabolic encephalopathy or impaired myocardial contractility.
**ELECTROLYTE MANAGEMENT - SODIUM**

- Plasma sodium should **rise** as DKA is treated and as blood glucose falls.
- A falling plasma sodium is a risk factor for cerebral oedema.
- See Appendix II p36 for corrected sodium calculation.

---

**FIRST 12 HOURS REHYDRATION**

**Use 0.9% Sodium Chloride**

- **If sodium falls by >4mmol/L over 2-4 hours**
  - Repeat plasma sodium within 2 hours
  - Continues to fall
  - Slow rate of fluid replacement to correct deficit over 72 hours

- **Sodium stable/rising**
  - Continue 0.9% Sodium Chloride

---

**CALCULATION**

See next page

- **Sodium stable or increasing**
  - Change to 0.45% Sodium Chloride +/− 5% Glucose as indicated

- **Sodium falling**
  - Continue to 0.9% Sodium Chloride +/− 5% Glucose as indicated
Integrated Care Pathway: Diabetic Ketoacidosis

**FLUID REPLACEMENT TO CORRECT DEFICIT OVER 72 HRS**

\[
\frac{(72 \text{ hour maintenance} + \text{deficit}) - \text{resuscitation fluid already given}}{72}
\]

Show calculations in the boxes below.

**STEP 1**

\[
24\text{hr Maintenance} = \text{ml}
\]

\[
72\text{hr Maintenance} = \text{ml}
\]

\[
\text{Deficit} = \text{ml}
\]

\[
\text{Resuscitation fluid already given} = \text{ml}
\]

**STEP 2**

\[
72 \text{ hour maintenance} + \text{deficit} - \text{resuscitation fluid already given} = \text{total volume over 72hrs ml}
\]

**STEP 3**

\[
\text{total volume over 72hrs ml} \div 72 = \text{hourly volume ml}
\]
MANAGEMENT OF INTRAVENOUS INSULIN INFUSION

Step 1: To Reach Blood Glucose Value of 13mmol/l

Blood glucose levels will often fall quickly initially simply because of rehydration. Small increments in insulin can make a significant difference but may take an hour for the effect to be observed.

**Blood Glucose**

- **Falling > 1mmol/L/hr**
  - Continue with current rate until BG ≤ 13mmol/L

- **Remains constant (±1mmol/L of previous reading)**
  - Repeat in 1 hour

- **Increasing Rises by >1mmol/L/hour**
  - BG decreased by > 1mmol/L
    - **Yes**
      - Increase insulin infusion rate:
        - by 0.1ml/hour if child <10 years
        - by 0.2ml/hour if child ≥10 years
    - **No**

**Change fluids when BG ≤ 13mmol/L**
- Review p23 (sodium page)
  - >12 hours since start ICP → 0.45% sodium chloride + 5% glucose
  - <12 hours since start ICP → 0.9% sodium chloride + 5% glucose

**Target BG ≤ 13mmol/L reached**

Move on to Step 2 (and do not return to Step 1)
Management of Intravenous Insulin Infusion

Step 2: To Maintain Blood Glucose Target Levels of 7-13 mmol/L

Remember that when IV fluids change to include glucose, the blood glucose will rise. Do not reduce glucose content of IV fluids in response to this.

Rising Blood Glucose
- Increases by ≥3mmol/L/Hour
  OR
  If ≥13mmol/L

  Age <10 years
  Increase insulin infusion rate by 0.1ml/hour

  Age ≥10 years
  Increase insulin infusion rate by 0.2ml/hour

Falling Blood Glucose
- Falls to <7mmol/L
  Change immediately to 0.45% or 0.9% sodium chloride (see Sodium Management p23) + 10% glucose without decreasing rate of insulin infusion.

  Falls to <4mmol/L
  See Troubleshooting (see Appendix II p36)

Document all fluid/insulin changes on Hourly Recording Chart, p37.
CONTINUING CARE INSULIN

End point of IV insulin infusion is reached when pH > 7.3 and 2 consecutive POCT blood ketone readings thereafter are <1 mmol/L, indicating resolution of ketoacidosis.

Aim to change to subcutaneous insulin just prior to a mealtime; breakfast, tea, lunch or supper.

A. For newly diagnosed child in DKA: commence basal bolus regimen

Start ICP 3 to prescribe insulin doses

B. For known patients in DKA: re-commence own insulin regimen

Start ICP 2 to prescribe insulin doses

Points to note:

- Sign insulin prescribing sheet on follow on ICP when insulin administered.
- Ensure prescribed amount of carbohydrate (carbs) provided.
- Discontinue the insulin infusion 10 minutes after the first Novorapid/Humalog injection is given to avoid rebound hyperglycaemia.
- Discontinue the IV fluids after the IV insulin infusion has been stopped and the child has been able to eat prescribed amount of carbohydrate.

Date and time that child is ready to transfer to Ward 1
**Integrated Care Pathway:**
**Diabetic Ketoacidosis**

**DATE:**

**WARD:**

**D.O.B.:**

---

**MEDICAL STAFF ACTIONS**

**Frequent Review of Child Necessary**

**ACTION:** Record on Medical and Diabetes Team Review p29-30

**Veneupuncture**

*Review the fluid composition and rate according to each set of electrolyte results*

- Check biochemistry, blood pH and laboratory blood glucose 2 hours after the start of resuscitation.

**ACTION:** Sign at time of venepuncture

*Remember to record and review results on p33-34*

**SIGNATURE:**

**DATE:**

**TIME:**

- Check biochemistry, laboratory blood glucose + blood pH 4 hourly until pH ≥ 7.3, thereafter check biochemistry + laboratory blood glucose only as indicated.

**SIGNATURE:**

**DATE:**

**TIME:**

**SIGNATURE:**

**DATE:**

**TIME:**

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### MEDICAL AND DIABETES TEAM REVIEW

Medical Review required at least 4 hourly

<table>
<thead>
<tr>
<th>DATE</th>
<th>TIME</th>
<th>SEEN BY</th>
<th>COMMENTS INCLUDING EXAMINATION AS NECESSARY AND DOCUMENTATION OF VARIATION</th>
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</table>
# Medical and Diabetes Team Review

Medical Review required at least 4 hourly

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<th>SEEN BY</th>
<th>COMMENTS INCLUDING EXAMINATION AS NECESSARY AND DOCUMENTATION OF VARIATION</th>
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MANAGEMENT OF CEREBRAL OEDEMA

Warning signs and symptoms of cerebral oedema include:

1. Headache and slowing of heart rate
2. Change in neurological status (restlessness, irritability, increasing drowsiness and incontinence).
   A falling GCS is abnormal (see Appendix I).
3. Specific neurological signs (e.g. cranial nerve palsies)
4. Rising blood pressure
5. Decreasing oxygen saturation
6. Abnormal posturing

More dramatic changes (convulsions, papilloedema, respiratory arrest) are late signs associated with an extremely poor prognosis.

Management

Exclude hypoglycaemia as a possible cause of any behavioural change, then:

Either \(^{+}\) Hypertonic (2.7%) sodium chloride (5ml/Kg over 5-10 mins) or

10\% \(^{++}\) Mannitol 0.25 – 1.0g/Kg (2.5 – 10ml/Kg over 20 mins)

*Check Mannitol for particles and warm fluid if crystals present

OR

If suspected inform on call medical consultant and liaise with PICU staff.
Initiate treatment immediately

Show calculation

Show calculation

Elevate head of bed.
Restrict IV fluids to 50\% maintenance and replace deficit over 72 hours instead of 48 hours.
After child is stable consider CT scan to exclude other intracerebral events (thrombosis, haemorrhage or infarction).

\(^{+}\) **CAUTION: Confirm patency of IV access as risk of extravasation with these fluids**

Scan report
CEREBRAL OEDEMA
Restrict IV fluids to 50% maintenance and replace deficit over 72 hours instead of 48 hours

Show calculations in the boxes below.

**STEP 1**

<table>
<thead>
<tr>
<th>24hr Maintenance = ml</th>
<th>72hr 50% Maintenance = ml</th>
</tr>
</thead>
<tbody>
<tr>
<td>(calculated p16)</td>
<td>(3 x 24hr) ÷ 2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Deficit = ml</th>
</tr>
</thead>
<tbody>
<tr>
<td>(calculated p16)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Resuscitation fluid already given = ml</th>
</tr>
</thead>
<tbody>
<tr>
<td>(calculated p8)</td>
</tr>
</tbody>
</table>

**STEP 2**

\[
\text{total volume over 72hrs} = \text{72 hour 50% maintenance} + \text{deficit} - \text{resuscitation fluid already given} \]

**STEP 3**

\[
\text{restricted hourly volume} = \frac{\text{total volume over 72hrs}}{72} \]

DATE: WARD: D.O.B.:
### Integrated Care Pathway: Diabetic Ketoacidosis

**DATE:**

**WARD:**

**UNIT NO.:**

**D.O.B.:**

#### DOCUMENTATION OF BLOOD RESULTS

<table>
<thead>
<tr>
<th>Date</th>
<th>Time</th>
<th>Source</th>
<th>Na</th>
<th>K</th>
<th>CI</th>
<th>Urea</th>
<th>Creatinine</th>
<th>Glucose</th>
<th>HbA1c</th>
<th>Ca</th>
<th>Mg</th>
<th>Albumin</th>
<th>Protein</th>
<th>Bilirubin Total</th>
<th>ALT</th>
<th>GGT</th>
<th>Plasma - Osmolality</th>
<th>Urine - Osmolality</th>
<th>Hb</th>
<th>Hct</th>
<th>WCC</th>
<th>Neutrophils</th>
<th>Lymphocytes</th>
<th>Monocytes</th>
<th>Platelets</th>
<th>pH</th>
<th>pO₂</th>
<th>pCO₂</th>
<th>Base excess</th>
<th>Bicarbonate</th>
</tr>
</thead>
</table>

**Results seen by Medical Staff and appropriate action taken**

**Time**
Integrated Care Pathway: Diabetic Ketoacidosis

<table>
<thead>
<tr>
<th>Date</th>
<th>Time</th>
<th>Source</th>
<th>Na</th>
<th>K</th>
<th>Cl</th>
<th>Urea</th>
<th>Creatinine</th>
<th>Glucose</th>
<th>HbA1c</th>
<th>Ca</th>
<th>Mg</th>
<th>Albumin</th>
<th>Protein</th>
<th>Bilirubin Total</th>
<th>ALT</th>
<th>GGT</th>
<th>Plasma - Osmolality</th>
<th>Urine - Osmolality</th>
<th>Hb</th>
<th>Hct</th>
<th>WCC</th>
<th>Neutrophils</th>
<th>Lymphocytes</th>
<th>Monocytes</th>
<th>Platelets</th>
<th>pH</th>
<th>pO₂</th>
<th>pCO₂</th>
<th>Base excess</th>
<th>Bicarbonate</th>
</tr>
</thead>
</table>

**Results seen by Medical Staff and appropriate action taken**

**DATE:**

**WARD:**

**Affix ID label or complete**

**PATIENT NAME:**

**UNIT NO.:**

**D.O.B.:**

**DOCUMENTATION OF BLOOD RESULTS**
## APPENDIX I - Glasgow Coma Scale

| 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 | 1 = none  
|                      | 2 = incomprehensible words  
|                      | 3 = inappropriate words  
|                      | 4 = appropriate words but confused  
|                      | 5 = fully orientated  |

Maximum score 15, minimum score 3

Modification of verbal response for younger children

<table>
<thead>
<tr>
<th>2-5 years</th>
<th>&lt;2 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 = none</td>
<td>1 = none</td>
</tr>
<tr>
<td>2 = grunts</td>
<td>2 = grunts</td>
</tr>
<tr>
<td>3 = cries or screams</td>
<td>3 = inappropriate crying or unstimulated screaming</td>
</tr>
<tr>
<td>4 = monosyllables</td>
<td>4 = cries only</td>
</tr>
<tr>
<td>5 = words of any sort</td>
<td>5 = appropriate non-verbal responses (coos, smiles, cries)</td>
</tr>
</tbody>
</table>
APPENDIX II - Troubleshooting

A. Blood glucose less than 4 mmol/L:
- Ensure IV insulin running at correct rate
- Ensure IV fluids appropriate and running correctly
- If pH ≥ 7.3 give 10g glucose powders orally in 20mls water
- If pH < 7.3 give IV 10% glucose 2ml/Kg bolus
- Decrease insulin infusion rate by 20% if no issues identified

B. Blood Ketones
Expect blood ketone levels to fall as insulin therapy switches off ketogenesis
However at presentation it may take several hours to begin to see a fall in levels
If levels not falling:
- check infusion lines
- check the calculation and dose of insulin
- consider sepsis and inadequate fluid input if sufficient insulin is being given

C. Acidosis
Acidosis will almost certainly correct with correction of fluid balance.
Remember pH is a log scale and therefore small improvements in pH are significant.
If acidosis is not correcting, consider the following:
- Insufficient insulin to switch off ketones
- Inadequate resuscitation
- Sepsis
- Hyperchloremic acidosis
- Salicylate or other prescribed or recreational drugs

D. Corrected Sodium levels
Note: a failure to increase the corrected sodium level = a risk of cerebral oedema
Simplified corrected sodium formula:

Corrected sodium = plasma sodium plus (0.3 x (glucose – 5.5))
Corrected sodium should rise with therapy (0.5 – 1 mmol/hr)
**Integrated Care Pathway: Diabetic Ketoacidosis**

**DATE:**  
**WEIGHT:**

**PATIENT NAME:**

**UNITH NO.:**

**Affix ID label or complete**

<table>
<thead>
<tr>
<th>Time</th>
<th>Glucose</th>
<th>Level</th>
<th>Rate change</th>
<th>Amt</th>
<th>Total</th>
<th>Type</th>
<th>Amt</th>
<th>Total</th>
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</thead>
<tbody>
<tr>
<td>In</td>
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</table>

**BLOOD POOT**

**INSULIN**

**BLOOD POOT**

**For example, 0.9% Sodium Chloride + 20mmols KCl = 1B**

**Sign if changing**

**KCl: A = 10mmol D = 40mmol**

**B = 20mmol E = None**

**C = 30mmol**

**Type: 1 = 0.9% (per 500ml)**

**2 = 0.9% + 5%**

**3 = 0.45% + 5%**

**4 = 0.45% + 10%**
Royal Hospital for Sick Children Edinburgh

Integrated Care Pathway: Diabetic Ketoacidosis

**DATE:**  
**WEIGHT:**  
**D.O.B.:**

<table>
<thead>
<tr>
<th>BLOOD POCT</th>
<th>INSULIN</th>
<th>IV FLUIDS</th>
<th>ORAL FLUIDS</th>
<th>URINE</th>
<th>GI LOSSES</th>
<th>BALANCE SINCE ADMISSION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time</td>
<td>Glucose</td>
<td>Ketones</td>
<td>Units/ Kg/hr</td>
<td>Level</td>
<td>Rate change</td>
<td>Type</td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>A = 10mmol</td>
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<td></td>
<td></td>
<td>B = 20mmol</td>
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<td></td>
<td></td>
<td></td>
<td>C = 30mmol</td>
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</table>

*Sign if changing.*

© Diabetes Team, Royal Hospital for Sick Children, Edinburgh, 2015

**DIABETES ICP 01 / V5**
## Integrated Care Pathway: Diabetic Ketoacidosis

**Royal Hospital for Sick Children Edinburgh**

### Key Points

- **DATE:**
- **WEIGHT:**
- **UNIT NO.:**
- **PATIENT NAME:**
- **Affix ID label or complete**

### Table: Blood POCT

<table>
<thead>
<tr>
<th>Time</th>
<th>Glucose</th>
<th>Ketones</th>
<th>Units/Kg/hr</th>
<th>Rate change</th>
<th>Amt</th>
<th>Total</th>
</tr>
</thead>
</table>

### Table: Insulin

<table>
<thead>
<tr>
<th>Type</th>
<th>Amt</th>
<th>Total</th>
</tr>
</thead>
</table>

### Table: Intravenous Fluids

- **Type:** 1 = 0.9% (per 500ml)
- **Type:** 2 = 0.9% + 5%
- **Type:** 3 = 0.45% + 5%
- **Type:** 4 = 0.45% + 10%

**For example, 0.9% Sodium Chloride + 20mmol KCl = 1B**

### Table: Oral Fluids

- **Type:** A = 10mmol
- **Type:** B = 20mmol
- **Type:** C = 30mmol

### Table: GI Losses

- **Type:** D = 40mmol
- **Type:** E = None

### Table: Urine

**Sign if changing**

<table>
<thead>
<tr>
<th>Time</th>
<th>Volume</th>
<th>Glucose</th>
<th>Insulin</th>
<th>Ketones</th>
<th>Rate change</th>
<th>Amt</th>
<th>Total</th>
</tr>
</thead>
</table>

### Table: Balance since Admission

- **Type:** In
- **Type:** Out
- **Type:** Total

### Instructions

- **Affix ID label or complete**
- **PATIENT NAME:**
- **UNIT NO.:**
- **D.O.B.:**

---

**Integrated Care Pathway: Diabetic Ketoacidosis**

Royal Hospital for Sick Children Edinburgh
# Integrated Care Pathway: Diabetic Ketoacidosis

<table>
<thead>
<tr>
<th>DATE:</th>
<th>WEIGHT:</th>
<th>D.O.B.:</th>
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</table>

**BLOOD POCT**

- Time
- Glucose
- Ketones
- Units/Kg/hr
- Level
- Rate change
- Amt
- Total
- Type
- Level
- Amt
- Total

**INSULIN**

- Yes/No
- Sig

**IV FLUIDS**

- Type: 1 = 0.9%
- 2 = 0.9% + 5%
- 3 = 0.45% + 5%
- 4 = 0.45% + 10%
- For example, 0.9% Sodium Chloride + 20mmols KCl = 1B

- KCl: A = 10mmol
- B = 20mmol
- C = 30mmol
- D = 40mmol
- E = None

**ORAL FLUIDS**

- Type
- Amt
- Total

**URINE**

- Type
- Amt
- Total

**GI LOSSES**

- Type
- Amt
- Total

**BALANCE SINCE ADMISSION**

- In
- Out
- Total

*Sign if changing*
### Integrated Care Pathway: Diabetic Ketoacidosis

Date:  Weight:  

Affix ID label or complete

**PATIENT NAME:**  

**UNIT NO.:**  

**D.O.B.:**

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<th>Ketones</th>
<th>Insulin Type</th>
<th>Insulin Amt</th>
<th>Total Amt</th>
<th>IV Fluids Type</th>
<th>IV Fluids Amt</th>
<th>Total Amt</th>
<th>Oral Fluids Type</th>
<th>Oral Fluids Amt</th>
<th>Total Amt</th>
<th>GI Losses Type</th>
<th>GI Losses Amt</th>
<th>Total Amt</th>
<th>Urine Type</th>
<th>Urine Amt</th>
<th>Total Amt</th>
<th>Balance Since Admission</th>
</tr>
</thead>
</table>

**Blood Pocket**:

- 4 = 0.4% + 10%
- 3 = 0.4% + 5%
- 2 = 0.9% + 5%
- 1 = 0.9%

For example, 0.9% Sodium Chloride + 20mmols KCl = 1B

KCl: A = 10mmol  
D = 40mmol  
B = 20mmols  
C = 30mmols  
E = None

**Sign if changing**

**Date:**
# Integrated Care Pathway: Diabetic Ketoacidosis

## PARENTERAL INFUSION PRESCRIPTION

<table>
<thead>
<tr>
<th>Date</th>
<th>Fluid</th>
<th>Fluid Volume ml</th>
<th>Additive</th>
<th>Amount</th>
<th>Infusion Rate ml/hr</th>
<th>Prescriber (signature)</th>
<th>Time of Addition</th>
<th>Batch No. of fluid</th>
<th>Batch No. of additive</th>
<th>Prepared &amp; set up (signature)</th>
<th>Checked by (signature)</th>
<th>Equipment Serial Number</th>
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Integrated Care Pathway: Diabetic Ketoacidosis

Royal Hospital for Sick Children, Edinburgh
# Integrated Care Pathway: Diabetic Ketoacidosis

## PARENTERAL INFUSION PRESCRIPTION

<table>
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<tr>
<th>Date</th>
<th>Fluid</th>
<th>Fluid Volume mls</th>
<th>Additive</th>
<th>Amount</th>
<th>Infusion Rate mls/hr</th>
<th>Prescriber (signature)</th>
<th>Time of Addition</th>
<th>Batch No. of fluid</th>
<th>Batch No. of additive</th>
<th>Prepared &amp; set up (signature)</th>
<th>Checked by (signature)</th>
<th>Equipment Serial Number</th>
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Integrated Care Pathway: Diabetic Ketoacidosis

**PARENTERAL INFUSION PRESCRIPTION**

<table>
<thead>
<tr>
<th>Date</th>
<th>Fluid</th>
<th>Volume (mls)</th>
<th>Active Additive</th>
<th>Amount</th>
<th>Infusion Rate (mls/hr)</th>
<th>Prescriber (signature)</th>
<th>Time of Addition</th>
<th>Batch No. of fluid</th>
<th>Batch No. of active additive</th>
<th>Prepared &amp; set up (signature)</th>
<th>Checked by (signature)</th>
<th>Equipment Serial Number</th>
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**DATE:**  
**WEIGHT:**

Affix ID label or complete