

1. Introduction

- 1.1 This document sets out the guidelines for the management of Diabetic Ketoacidosis (DKA) in adults and is based on the Joint British Diabetes Societies (JBDS) guideline "The Management of Diabetic Ketoacidosis in Adults, published in March 2010. A National guideline was produced in response to the knowledge that most acute hospitals had their own guidelines and these were at variance to those of other hospitals.
- 1.2 There are some key changes recommended by the JBDS in the management of DKA and these have been incorporated into this guideline, the changes include:
 - a) Use of venous rather than arterial blood sampling if possible
 - b) Monitoring of blood ketone levels (using a near patient "finger prick" testing kit) – if available
 - c) Use of 10% glucose when blood glucose level < 14mmol/l alongside crystalloid fluid replacement
 - d) Continuation of long acting analogue insulin (if patient normally uses one)
 - e) Fixed rate insulin infusion based on patient's weight rather than variable (sliding scale) rate
- 1.3 **The fundamentals however remain the same e.g. replacement of fluid deficit, insulin treatment and monitoring and maintaining electrolyte / potassium balance in a safe environment.**
- 1.4 DKA can be complex condition to manage. Mortality associated with DKA is largely preventable if correctly managed. The commonest causes of death associated with DKA are
 - a) Cerebral oedema – especially in children and adolescents
 - b) Hypokalaemia, Adult Respiratory Distress Syndrome (ARDS), co-morbid conditions (e.g. pneumonia) in the elderly

2. Scope

This guideline applies to all adult inpatients with Diabetes and to all Healthcare Professionals who are responsible for the clinical management and / or care of these patients.

Usually DKA will be diagnosed and managed within the Emergency Department and LRI ward 15 Acute Care Bay (ACB). However, occasionally patients develop DKA whilst an inpatient and this could occur in any ward area within UHL. Were this to occur please refer to Section 4.0 below for advice regarding provision of care.

2.1 Roles and Responsibilities

It is expected that all registered staff working in the Emergency Department (ED), LRI admissions (Acute Care Bay (ACB), Wards 15 & 16) and the Diabetes wards (LRI wards 34 & 38) have a responsibility to understand the management of DKA and up-date their knowledge. They will be supported by the Diabetes team but staff would be expected to have undertaken the National e-learning modules relating to The Safe Use of Insulin and The use of Intravenous Insulin Infusion (www.diabetes.nhs.uk).

2.2 All clinical staff working in any location within UHL would be expected to seek senior advice if they were presented with a patient with DKA and they did not feel adequately trained to manage the clinical case.

ADULT DIABETIC KETOACIDOSIS PRESCRIPTION CHART

Patient's addressograph

For more information refer to UHL guidelines on DKA management. Abridged version available on pages 2 & 3 of this chart. Monitoring chart on page 4.

Date Ward

Consultant

Patient's weight (kg)

1) INTRAVENOUS FLUIDS should be commenced via a large IV cannula (green or grey). If there is a problem with intravenous access critical care support should be requested immediately. Be aware of any fluids that may have already been given in the ambulance or ED.

Sodium chloride 0.9%	Rate mL/hour (circle as appropriate)	Prescriber & bleep No.	Administered by	2nd Nurse check	Time & date commenced
1st Litre over 1hr	Sodium chloride 0.9% 500ml/30mins Sodium chloride 0.9% 500ml/30mins	1000/other *			

* A slower rate and reduced volume of infusion should be considered when patients are under 25 years of age or over 70 years of age, pregnant, patients with heart or known chronic kidney failure (eGFR <30mL/min and dialysis patients - refer to nephrologist on call). If systolic BP <90mmHg give 500ml over 15minutes (see Box A on page 2)

	STANDARD INFUSION RATE; AMEND ACCORDING TO PATIENT FLUID STATUS	Rate mL / hour (circle as appropriate)	Potassium Check potassium & correct as appropriate (circle as appropriate)	Prescriber & bleep No.	Administered by	2nd Nurse check	Time & date commenced
2nd Litre over 2hrs	Sodium chloride 0.9% 500ml/hr Sodium chloride 0.9% 500ml/hr	500/ other.....	Nil/20mmol in 500ml other.....				
3rd Litre over 2hrs	Sodium chloride 0.9% 500ml/hr Sodium chloride 0.9% 500ml/hr	500/ other.....	Nil/20mmol in 500ml other.....				
4th Litre over 4hrs	Sodium chloride 0.9% 500ml/2hrs Sodium chloride 0.9% 500ml/2hrs	250/ other.....	Nil/20mmol in 500ml other.....				
5th Litre over 4hrs	Sodium chloride 0.9% 500ml/2hrs Sodium chloride 0.9% 500ml/2hrs	250/ other.....	Nil/20mmol in 500ml other.....				
6th Litre over 6hrs	Sodium chloride 0.9% 500ml/3hrs Sodium chloride 0.9% 500ml/3hrs	166/ other.....	Nil/20mmol in 500ml other.....				
7th Litre over 6hrs	Sodium chloride 0.9% 500ml/3hrs Sodium chloride 0.9% 500ml/3hrs	166/ other.....	Nil/20mmol in 500ml other.....				

By 24 hours the ketonaemia and acidosis should have resolved. Continue IV fluids if patient is not yet eating & drinking as per clinical judgment. If using in combination with 10% glucose remember to review rate to avoid fluid overload

MONITOR PATIENT FOR FLUID OVERLOAD AND CEREBRAL OEDEMA

Any sudden deterioration in the patient's level of consciousness should be considered as likely cerebral oedema until definitively proven otherwise

When blood glucose < 14 mmol/L prescribe 10% glucose 500mL at 125mL/hour to run alongside sodium chloride

Review rate of sodium chloride infusion to avoid fluid overload, eg. likely to need to reduce rate of Sodium chloride 0.9% if 10% glucose running at 125ml/hr

	Rate mL / hour (circle as appropriate)	Prescriber & bleep No.	Administered by	2nd Nurse check	Time & date commenced
10% glucose 500ml	125/other				
10% glucose 500ml	125/other				
10% glucose 500ml	125/other				
10% glucose 500ml	125/other				

2) POTASSIUM PRESCRIPTION ADVICE (If rate of potassium exceeds 10mmol / hour, cardiac monitoring is essential.)

Potassium level in first 24 hours (mmol/L)	Potassium replacement in mmol / 500mL of infusion solution
Over 5.5	Nil
3.5 to 5.5	20mmol/500mL
Below 3.5	Senior review, since additional potassium needs to be given

3) INSULIN (Human soluble insulin e.g. Human Actrapid or Insuman Rapid)

Give stat dose of soluble insulin either s/c or i/m. Start IV insulin infusion via a pump, containing 50 units soluble insulin in 50mL 0.9% sodium chloride at a continuous fixed rate of 0.1 units/kg/hour. If unable to weigh patient then estimate weight. Monitor ketones and capillary blood glucose hourly and adjust rate as per guidance over page. If patient normally takes long acting insulin such as Glargine (Lantus) or Detemir (Levemir) subcutaneously, continue this at the usual dose and time, prescribe on in-patient drug chart.

INSULIN	Initial rate mL / hour	Prescriber & bleep No.	Administered by	2nd Nurse check	Time & date commenced
Stat dose of 10 units soluble insulin sc or im					
Soluble insulin 50 units in 50mL Sodium chloride 0.9% iv					
Soluble insulin 50 units in 50mL Sodium chloride 0.9% iv					
Soluble insulin 50 units in 50mL Sodium chloride 0.9% iv					

Reference copy only
Prints must be obtained via print room

ADULT DIABETIC KETOACIDOSIS - PRESCRIPTION CHART

(Higgins)12114547(SJ)

Abridged ADULT DIABETIC KETOACIDOSIS (DKA) MANAGEMENT GUIDELINES

CONFIRM DIAGNOSIS OF DKA - all of following present:

- Significant ketonuria (>2+) or blood ketone >3mmol/L
- Blood glucose >11mmol/L or known diabetes mellitus
- Bicarbonate <15mmol/L or venous pH <7.3

IMMEDIATE ACTIONS:

- Rapid ABC with measurement of RR, temp, pulse, BP, EWS, GCS, and pulse oximetry
- Capillary blood glucose check and blood ketones
- Obtain urgent IV access and commence IV fluids (Box A action 2) - if there is a problem request critical care support
- Stat dose of 10 units soluble insulin sc or im
- Venous sample for - U&Es, blood ketones, bicarbonate measured by venous blood gas, FBC
- Urinalysis for ketones

The presence of one or more of the following may indicate severe DKA - obtain immediate senior review and consider admission to HDU/ITU:

- Blood ketones above 6mmol/L
- Venous bicarbonate level below 5mmol/L
- Venous or arterial pH below 7.1
- Hypokalaemia on admission (below 3.5mmol/L)
- Anion gap above 16 [$(\text{Na}^+ + \text{K}^+) - (\text{Cl}^- + \text{HCO}_3^-)$]
- GCS less than 12 (or abnormality on AVPU scale)
- Oxygen saturation below 92% on air (assuming normal baseline respiratory function)
- Systolic BP below 90 mmHg
- Pulse over 100 or below 60 bpm

BOX A: Immediate management upon diagnosis: (0 to 60 minutes)

(t=0 at time intravenous fluids are commenced)

Action 1	Urgent initial assessment as above
Action 2	<p>Commence 0.9% sodium chloride infusion via infusion pump</p> <ul style="list-style-type: none"> • <u>Systolic BP on admission above 90 mmHg</u> Prescribe fluids and follow fluid replacement schedule on page 1 • <u>Systolic BP on admission below 90 mmHg</u> Hypotension is likely to be due to low circulating volume, but consider other causes such as heart failure, sepsis, etc. Give 500mL of 0.9% sodium chloride solution over 15 minutes. If SBP remains below 90mmHg this may be repeated whilst awaiting senior input. In practice most patients require between 500 to 1000mL given rapidly. Once SBP above 90mmHg follow fluid replacement schedule on page 1.
Action 3	Give stat dose of 10 units soluble insulin s/c or i/m - prescribe on page 1
Action 4	<p>Potassium replacement</p> <p>Hypokalaemia and hyperkalaemia are life threatening conditions and are common in DKA. Potassium is often high on admission but falls precipitously upon treatment with insulin. Add potassium as per schedule on page 1 when U&Es known.</p>
Action 5	<p>Commence fixed rate intravenous insulin infusion (IVII)</p> <p>0.1unit/kg/hr based on actual or estimated weight - prescribe on page 1 Use 50units human soluble insulin (Actrapid or Insuman Rapid) in 50ml sodium chloride 0.9% If patient usually takes long-acting insulin analogue (Lantus or Levemir) then continue at usual dose and time Insulin may be given through same line as iv fluids using a Y connector</p>
Action 6	<p>Complete full history and clinical examination</p> <p>Consider ITU/HDU if above guidelines indicate severe DKA</p>
Action 7	<p>Consider further investigations</p> <p>CXR, ECG, MI screen, MSU, blood cultures</p>
Action 8	<p>Establish monitoring regimen and ensure senior review occurs (SpR / Consultant)</p> <p>Use 24 hour DKA monitoring form on page 4 Capillary glucose, U&Es (including venous bicarbonate and potassium) to be repeated at 60 minutes Continuous pulse oximetry and cardiac monitoring if required</p>
Action 9	<p>Prescribe thromboprophylaxis on main drug chart - if indicated</p> <p>Consider precipitating cause and treat appropriately</p>
Action 10	<p>Refer to Diabetes Team</p> <p>Diabetes nurses may be contacted on iCM or bleep diabetes SpR during normal working hours on bleep 4264</p>
Action 11	<p>Ward location and supervising consultant</p> <p>Patients should be managed initially on the AMU 15 in the Acute Care Bay (unless ITU/HDU bed required). Once stabilised transfer to one of the Diabetes wards, under the care of a Diabetes consultants if possible</p>
Action 12	<p>Intravenous bicarbonate is very rarely necessary</p> <p>If pH <7.1 and not improving contact critical care team</p>

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BOX B: Management from 60 minutes to 6 hours

Aims	<ul style="list-style-type: none"> • Venous bicarbonate rise of at least 3 mmol/L/hr OR rate of fall of ketones of at least 0.5mmol/L/hr and blood glucose fall of at least 3mmol/L/hr • Maintain serum potassium in normal range • Avoid hypoglycaemia
Action 1	<p>Re-assess patient and continue to monitor vital signs - ensure that patient has had a senior review (SpR / Consultant)</p> <ul style="list-style-type: none"> • Consider urinary catheterisation if incontinent or anuric (ie not passed urine by 60 minutes) • Consider nasogastric tube if patient obtunded or if persistently vomiting • If oxygen saturation falling measure ABGs and request (or repeat) CXR • Document accurate fluid balance including urine output (minimum desired output = 0.5ml/kg/hr)
Action 2	<p>Review metabolic parameters</p> <ul style="list-style-type: none"> • Measure and record hourly capillary blood glucose (lab glucose if meter reading 'HI') and blood ketone level • Measure venous blood gas for pH, bicarbonate and potassium at 60minutes, 2 hours and 2 hourly thereafter • Repeat U&Es at 60 minutes, 2 hours and 2 hourly thereafter • Complete DKA monitoring chart on Page 4 for all monitoring parameters.
Action 3	<p>Assess response to treatment with insulin infusion, rate may need review if:</p> <ul style="list-style-type: none"> • Venous bicarbonate not rising by at least 3mmol/L/hr or blood ketone level not falling by 0.5mmol/L/hr • Plasma glucose not falling by at least 3 mmol/L/hr • If ketone level, bicarbonate or glucose not correcting as expected check iv lines, volumes of fluid remaining, look for insulin infusion pump malfunction. Blood ketones should fall by at least 0.5 mmol/l per hour (normal reading <0.3 mmol/l) • If pump working and connected but metabolic response inadequate, increase insulin infusion rate by 1 unit/hr increments until targets achieved • Continue IVII until venous pH >7.3 and/or venous bicarbonate >18 mmol/L and/or blood ketones <0.3 mmol/l and patient eating and drinking • Do not rely on urine ketone clearance to indicate resolution of DKA because they are slowly cleared and may be present when DKA resolved
Action 4	<p>Continue fluid and potassium replacement via infusion pump</p> <ul style="list-style-type: none"> • Follow fluid replacement schedule on Page 1 - when blood glucose is less than 14mmol/L add 10% at glucose at 125 ml/hr to run alongside 0.9% sodium chloride - review fluid prescription to avoid fluid overload. • If potassium outside reference range, re-assess potassium replacement (as page 1) and check hourly. If abnormal after further hour seek senior medical advice.

BOX C: 6 to 12 HOURS

BOX D: 12 to 24 HOURS

		By 24 hours the ketonaemia and acidosis should have resolved. If not improving seek senior review	
Aims	<ul style="list-style-type: none"> • Ensure clinical and biochemical parameters are continuing to improve or are normal • Continue IV fluid replacement and iv insulin infusion until acidosis corrected and patient is eating and drinking • Avoid hypoglycaemia • Re-assess for complications of treatment such as fluid overload and cerebral oedema • Treat precipitating factors as necessary 		
Action 1	<p>Re-assess patient, monitor vital signs</p> <ul style="list-style-type: none"> • If patient not improving seek senior advice • Ensure referral made to Diabetes team - Diabetes nurses may be contacted on iCM or bleep diabetes SpR during normal working hours on bleep 4264 		
Action 2	<p>Review biochemical and metabolic parameters</p> <ul style="list-style-type: none"> • At 6 hrs check venous pH, potassium, bicarbonate and glucose • Resolution of DKA defined as venous pH >7.3 and/or venous bicarbonate >=18 and/or blood ketones <0.3 mmol/l • If DKA not resolved refer to Action 3 in Box B 	<p>Review biochemical and metabolic parameters</p> <ul style="list-style-type: none"> • At 12, 18 and 24 hrs check venous pH, potassium, bicarbonate and glucose • Resolution of DKA defined as venous pH >7.3 and/or venous bicarbonate >=18 and/or blood ketones <0.3 mmol/l • If remains acidotic (pH<7.3 and/or HCO3 <18 check blood ketones as may be alternative cause of persisting acidosis • If DKA not resolved refer to Action 3 in Box B and if in normal working hours, bleep diabetes SpR (bleep 4264) 	
Action 3	<p>When DKA resolved review insulin infusion to maintain capillary glucose 5-10 mmol/l and switch back to subcutaneous insulin when eating and drinking.</p> <p>Conversion to subcutaneous insulin in a newly diagnosed patient with Type 1 diabetes is best managed by the Specialist Diabetes Team. In patients previously known to have Type 1 diabetes their previous regimen is usually restarted; if on basal bolus regimen give usual pre-meal fast acting insulin and take IVII down 30 minutes later (ensuring that they have been receiving long acting insulin), if on bd pre-mixed insulin re-introduce before breakfast or evening dose and discontinue IVII 30 minutes later.</p>		

ADULT DIABETIC KETOACIDOSIS - MONITORING CHART

MONITORING CHART FOR ADULT PATIENTS IN DIABETIC KETOACIDOSIS

Chart No.

Name

Ward

TREATMENT AIM: Venous bicarbonate to rise by 3mmol / L / hr
 Blood ketones to fall by at least 0.5mmol / L / hr
 Blood glucose to fall by at least 3mmol / L / hr

RESOLUTION OF DKA: Venous Bicarbonate >18mmol / hr, Blood ketones <0.3mmol / L and pH > 7.3

Date:	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Hours from start																									
Capillary Glucose (mmol/L) (measure hourly and plot result on graph)																									
Insulin (0.1 unit/kg/hr)(units/hr)																									
0.9% sodium chloride (ml/ hour)																									
10% glucose (ml/ hour)																									
Blood ketone																									
Venous pH																									
Venous Potassium (mmol/L)																									
Venous Bicarbonate (mmol/L)																									

Start 10% glucose when glucose <14mmol/L

Reference copy only
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3. Establishing the Diagnosis of DKA

- 3.1 The diagnostic criteria for DKA are as follows, all three of the following should be present:
- Significant ketonuria ($\geq 2+$) or blood ketone $> 3\text{mmol/L}$
 - Blood glucose $> 11\text{mmol/L}$ or known diabetes mellitus
 - Bicarbonate $< 15\text{mmol/L}$ or venous pH < 7.3
- 3.2 The presence of one or more of the following **may** indicate severe DKA and may require admission to HDU/ITU and insertion of venous central line. Immediate senior/anaesthetic review should be considered:
- Blood ketones greater than 6mmol/L
 - Bicarbonate less than 5mmol/L
 - Venous / arterial pH less than 7.1
 - Hypokalaemia (less than 3.5mmol/L) on admission
 - GCS less than 12 or abnormal AVPU or EWS >6
 - Oxygen saturation less than 92% (assuming normal respiratory baseline)
 - Systolic BP less than 90mmHg
 - Pulse greater than 100 or less than 60 bpm
 - Anion gap greater than 16

N.B. Anion gap = $(\text{Na} + \text{K}) - (\text{Cl} + \text{HCO}_3)$

Note : The Medical Early Warning System (EWS) should be recorded when a patient arrives in a clinical area and appropriate action taken according to EWS score.

4.0 Special Considerations

- 4.1 Serious complications may arise during the management of DKA as a result of treatment. These include:
- Hypo or hyperkalaemia
 - Hypoglycaemia
 - Cerebral oedema
 - Pulmonary oedema
- 4.2 It is critical that the patient and treatment are regularly monitored and reviewed as per the guidelines in order to minimise the risk of these complications.
- 4.3 Groups of patients in whom extra caution is required in their care and management, particularly regarding fluid balance include:
- Young people aged 16-25 years
 - Elderly ($>70\text{yrs}$)
 - Pregnant (liaise with Obstetricians and Diabetes team regarding provision of care and management – gestation less than 24 weeks admit to medicine. For gestation greater than 24 weeks traditionally admitted to Labour ward but may be appropriate to be looked after on AMU with daily obstetric input – discuss with obstetric team)
 - Cardiac or renal failure
 - Other serious co-morbidities

5. Provision of Care for Patients with DKA

- 5.1.1 Adult patients with suspected DKA admitted to the LRI Emergency Department (ED) should have the diagnosis confirmed and their treatment initiated in ED. Patients should then be transferred to the Acute Care Bay (ACB) on ward 15, LRI or if clinically indicated, to ITU.
- 5.2 If a patient with DKA is admitted to ED or ACB then the SpR or Consultant should be informed and the patient should be reviewed by a senior member of the team immediately if the EWS indicates or directly after clerking and initiation of treatment by a junior member of the team if EWS does not indicate immediate senior review is required.
- 5.3 Patients who develop DKA in other LRI ward areas should have their treatment initiated according to this guideline by the ward team, they should be reviewed by the Diabetes SpR or Medical SpR on-call as soon as possible and transfer to ACB should be arranged. If DKA develops in a patient on a Diabetes ward (Ward 34 & 38, LRI) then an assessment can be made by the Diabetes SpR regarding whether the patient requires transfer to the ACB or whether treatment can be managed by the Diabetes ward team.
- 5.4 If DKA develops in a ward area at GGH or LGH then treatment should be initiated by the ward team and the patient should then be reviewed by the Diabetes SpR or Medical SpR on-call (depending on availability at each site) and a decision made regarding the appropriate area for the patient to be managed. In normal working hours (Mon-Fri, 9-5pm) there is both a Diabetes SpR and a Diabetes Consultant available to review/discuss cases. Both are contactable via LRI switch board.
- 5.6 If DKA develops outside of the ED or ACB then once immediate treatment has been initiated by the ward team then senior medical review should be sought as above. Referral for senior review should be made within the first hour of establishing the diagnosis and initiating treatment.

6. DKA Care Pathway

The following table details the DKA Care pathway divided into timed sections.

This pathway should be followed **once the diagnosis of DKA has been established** (Section 3.1).

Section A	Immediate management 0-60 minutes
Section B	60 minutes-6 hours
Section C	6-12 hours
Section D	12-24 hours
Section E	Conversion to subcutaneous insulin and safe discharge

DKA Care Pathway

Section A (0-60 mins)

Aims

- On arrival (Time=0mins) commence intravenous (iv) fluid. If access problems, involve critical care support immediately.
- Give 10 units soluble insulin (Actrapid® or Insuman Rapid®) stat either im or sc. (**See Action 1 below**)
- Commence IV 0.9% sodium chloride
- Commence IV fixed rate insulin
- Establish appropriate monitoring (hourly capillary blood glucose and blood ketones plus 2 hourly potassium by venous blood gas)
- Clinical and biochemical assessment of patient
- Review IV fluid regimen based on patient's clinical and biochemical assessment and blood glucose levels

Action 1 – intravenous (iv) access, initial investigations and stat dose of insulin

- Airway, Breathing, Circulation, **EWS**
- Large bore iv cannula and commence fluid replacement (for Regimen **see Action 2**)
- Give 10 units of soluble insulin (Actrapid® or Insuman Rapid®) either im or sc. (This is in case there is delay in starting iv insulin).
- Clinical assessment (RR, Temp, BP, Pulse, O₂ sats, EWS score, GCS, full clinical examination including patient's feet)
- Assessment of fluid status, monitor input / output – **essential to avoid fluid overload**
- Initial investigations (blood ketones, capillary blood glucose, venous plasma glucose, U&E, venous blood gases, FBC, ECG, CXR, urine dip and if indicated, MSU for culture)
- Blood cultures if clinically indicated
- Cardiac monitoring
- Pulse oximetry
- Consider precipitating causes and treat appropriately
- Establish usual medication for diabetes

Action 2 – Restoration of circulating volume and potassium replacement

If systolic BP < 90mmHg (systolic hypotension likely due to low circulating volume but caution in young and elderly or if other cause such as heart failure present)

- Give 500ml 0.9% sodium chloride – over 15mins
- Repeat if BP remains low whilst awaiting senior input

When systolic BP > 90 mmHg follow regimen in the table below which gives a guide for previously fit and well 70kg individual.

A slower infusion rate should be considered in young (16-25yrs), elderly patients (>70yrs) and those with renal or cardiac failure. (Insertion of a CVP line may be considered in such groups.)

Assessment of fluid balance to avoid fluid overload should be part of the on-going management in all patients.

DKA Care Pathway

	Fluid	Volume over time	Rate (ml/hr)
1 st Litre	0.9% sodium chloride*	1000ml over 1 hr	1000
2 nd Litre	0.9% sodium chloride +/- potassium chloride	1000ml over next 2 hr	500
3 rd Litre	0.9% sodium chloride +/- potassium chloride	1000ml over next 2 hr	500
4 th Litre	0.9% sodium chloride +/- potassium chloride	1000ml over next 4 hr	250
5 th Litre	0.9% sodium chloride +/- potassium chloride	1000ml over next 4 hr	250
6 th Litre	0.9% sodium chloride +/- potassium chloride	1000ml over next 6 hr	166

* potassium chloride may be required here if more than 1 litre of sodium chloride has been given to fluid resuscitate

Potassium level in first 24hrs (mmol/L)	Potassium replacement in mmol/L of infusion solution
Over 5.5	Nil
3.5 - 5.5	20 mmol per 500ml fluid
Below 3.5	Discuss with SpR/Consultant as additional potassium may need to be given

10% Glucose infusion

If capillary blood glucose <14mmol/L then sodium chloride +/- potassium infusion continued with 10% glucose should be given in addition at rate of 125ml/hr. Note: rate of sodium chloride infusion will need to be changed when 10% glucose infusion used in addition (see example below).

For example, if a patient is requiring 0.9% sodium chloride 250ml/hr and their blood glucose level falls to 8mmol/L then protocol recommends that 10% glucose is commenced in addition to 0.9% sodium chloride. 10% glucose should be given at a rate of 125ml/hr and therefore in order to avoid fluid overload the rate of NaCl would need reducing to 125ml/hr to maintain a total fluid input of 250ml/hr (125ml/hr 0.9% NaCl + 125ml/hr 10% glucose).

Regular review of cardiovascular status is critical

Action 3 – commencement of IV fixed rate insulin infusion

If weight unknown – estimate weight

If pregnant use present weight – discuss with diabetes team and obstetricians if uncertain

N.B. Do not delay initiation of IV insulin

If a patient takes a long acting analogue insulin (Glargine/Lantus® or Detemir/Levemir®) subcutaneously then continue this at usual time and dose as well as above IV regimen.

DKA Care Pathway

Commence insulin infusion at the following rate- 0.1unit/kg/hr. Intravenous insulin infusion is made up as 50 units of Human Soluble insulin diluted in 50ml normal saline and given at a rate determined by the patients weight (0.1unit/kg/hr).

Weight (kg)	iv insulin rate in unit/hour (based on 0.1unit/kg/hr)
55	5.5 units / hr
60	6.0 units / hr
65	6.5 units / hr
70	7.0 units / hr
75	7.5 units / hr
80	8.0 units / hr
85	8.5 units / hr
90	9.0 units / hr

Action 4 – Senior review

It is most important that patients with DKA are reviewed by a medical SpR/Consultant immediately if EWS indicates or once immediate management has been initiated if seen initially by a junior member of the team. It is the role of the junior medical team and the nursing staff to request a senior medical review.

In patients who develop DKA outside of ED or ACB the ward team should refer to the on-call SpR for Medicine or Diabetes SpR (depending on availability) within 1 hour of diagnosing DKA and initiating immediate treatment.

Use of IV Bicarbonate

Administration of bicarbonate is **not** recommended routinely. Its use should only be considered in those patients with severe DKA requiring discussion/involvement of the critical care team. Such patients are likely to require initial management on ITU/HDU. See Section 3.2 for indicators of severe DKA.

Section B (60 mins-6 hours)

Aims

- Clear the blood of ketones and suppress ketogenesis
- Achieve rate of fall of ketones of 0.5mmol/hr or rise in bicarbonate of 3mmol/L/hr
- Fall in blood glucose by 3mmol/L/hr
- Maintain serum potassium in normal range
- Avoid hypoglycaemia
- **Ensure that senior review by SpR or Consultant been undertaken**

DKA Care Pathway

Action 1 – Reassess the patient and monitor

- Consider urinary catheter if incontinent or not passed urine
- Consider NGT if reduced conscious level or persistent vomiting
- If oxygen saturations falling then perform arterial blood gas, rpt CXR and give O₂
- Regular vital signs and EWS charting and review
- Accurate fluid balance chart (minimum urine output 0.5ml/kg/hr)
- Cardiac monitoring for severe DKA
- Assess risk for VTE and give LMWH as per UHL guidelines (see reference section)

Action 2 – Review metabolic parameters

- Venous blood gas – pH, bicarbonate, potassium – at time 0mins, 60mins, 120mins and 2hrly thereafter
 - Potassium may need checking hourly if outside reference range this should be done by venous blood gas analysis rather than lab testing
 - **Monitor and replace potassium as it may fall rapidly (See Section A, Action 2)**
- Blood ketones – hourly
- Capillary blood glucose – hourly
- Measure blood ketones and capillary glucose hourly (if meter reads “HI” then venous blood should be sampled in lab or using blood gas analyser)
- Review whether blood ketones are falling satisfactorily – if not then check infusion pump is working, connected and correct insulin residual volume present. If no issues with infusion pump then increase infusion rate by 1unit / hr increments hourly until ketones are falling satisfactorily.
- If blood ketones are not available use venous bicarbonate to monitor progress – check rising by at least 3mmol/L/hr – if not then increase insulin infusion as above.
- If neither blood ketones or venous bicarbonate are available use capillary blood glucose and increase iv insulin as above if blood glucose not falling by at least 3mmol/L/hr
- When capillary blood glucose falls below 14mmol/L commence 10% glucose at 125ml/hr alongside 0.9% sodium chloride fluid replacement regimen, adjusting the fluid rate as appropriate (see example below).
- *For example, if a patient is requiring 0.9% sodium chloride 250ml/hr and their blood glucose level falls to 8mmol/L then protocol recommends that 10% glucose is commenced in addition to 0.9% sodium chloride. 10% glucose should be given at a rate of 125ml/hr and therefore in order to avoid fluid overload the rate of NaCl would need reducing to 125ml/hr to maintain a total fluid input of 250ml/hr (125ml/hr 0.9% NaCl + 125ml/hr 10% glucose).*

Action 3 – Identify and treat precipitating factors

Hypophosphatemia

Routine supplementation with phosphate is **not** recommended. If there is evidence of significant respiratory or skeletal muscle weakness then phosphate measurement and subsequent replacement may be considered if found to be low. There is a separate UHL guideline regarding phosphate replacement (see reference section).

DKA Care Pathway

Section C (6-12 hours)

Aims

- Ensure satisfactory clinical and biochemical improvement
- Continue intravenous fluid replacement
- Continue intravenous insulin administration
- Assess for complications of treatment (fluid overload, cerebral oedema)
- Continue to treat precipitating causes
- Avoid hypoglycaemia

Action 1 – Re-assess patient, monitor vital signs

- If not improving as desired (**see above Section B**), seek senior advice and contact the on-call Diabetes SpR, if within normal working hours. If out of hours contact the on-call SpR for Medicine.
- Ensure referral has been made to diabetes team (via iCM) – see appendix B

Action 2 – Review biochemical and metabolic parameters

- At 6 hours – venous pH, bicarbonate, potassium, blood ketones and glucose
 - Resolution of DKA defined as blood ketones < 0.3mmol/L, venous pH > 7.3 and/or venous bicarbonate >18mmol/L.
- Do not use bicarbonate as surrogate marker at this stage
NB Hyperchloraemic acidosis can occur secondary to high volumes of 0.9% sodium chloride. This can cause renal vasoconstriction and cause oliguria. However there is no evidence that hyperchloraemic acidosis causes a significant morbidity or prolongs length of stay
- Do not rely on clearance of urinary ketones to indicate resolution of DKA as these will still be present when DKA resolved
- **If DKA resolved go to Section E.**
- **If DKA not resolved refer back to Section B Action 2**

Section D (12-24 hours)

By 24 hours ketonaemia and acidosis should have resolved.

Aims

- Ensure that clinical and biochemical parameters are improving or normalised
- Continue iv fluids if not eating and drinking
- If patient not eating and drinking and blood ketones are normal (< 0.3mmol/L) change to UHL IV variable rate insulin regimen
- Re-assess for complications of treatment
- Continue to treat precipitating factors
- When patient eating and drinking normally transfer to subcutaneous regimen (Appendix A)

Action 1 – Re-assess patient and monitor vital signs

Action 2 – Review biochemical and metabolic parameters

- 12 hours – venous pH, bicarbonate, potassium, blood ketones, glucose
- Assess for resolution of DKA

If DKA resolved go to Section E.

- **If DKA not resolved refer to back to Section B Action 2** and seek senior specialist opinion from on-call diabetes SpR urgently, if within normal working hours.
If out of hours contact the on-call SpR for medicine.

DKA Care Pathway

Section E (24 hours onwards)

By now patients should be eating and drinking normally and back onto normal subcutaneous insulin

Action 1 – Conversion to subcutaneous insulin

Convert to an appropriate subcutaneous insulin regimen when biochemically stable and patient eating and drinking.

- For those newly diagnosed with type 1 diabetes, this should be managed by the diabetes team, but if not available (out of hours or at weekend) see Appendix A.
- For patients who have previously been on sc insulin, see guidance in Appendix A

Action 2 – Referral to specialist diabetes team via iCM if not already done – see appendix B

- A newly diagnosed individual with Type I diabetes should be seen by a member of the specialist team prior to discharge
- If this is not possible e.g. patient admitted and discharged (on subcutaneous insulin) over a weekend then the discharging team should ensure that the patient attends the Diabetes Clinic on the next working day.
- This can be arranged by the ward team telephoning the Diabetes Specialist nurses (ext. 5545) at the beginning of the day and they will advise where and when patient should attend.
- Alternatively the on-call diabetes SpR can be reached on bleep 4264.

7. Monitoring and Audit Criteria

Outcome measures will be to benchmark the incidence of DKA against equivalent national and regional data for admissions. To assess adherence to the guidelines, outcome measures and effectiveness, audit will be performed a year following implementation. We will aim to look at time to resolution of DKA, time to conversion to subcutaneous insulin and length of stay. This audit will be undertaken by the Diabetes team.

Data relating to the use of intravenous insulin will be audited on a yearly basis as part of the National Diabetes Inpatient Audit. This is automatically fed back to the trust.

Monitoring and audit will be led by the Chair of the Inpatient Diabetes Steering Group.

8. Reference section for local UHL guidelines

Guidelines for the Management of Hypophosphatemia (available on the UHL intranet as document 17295)

Prevention of Foot Complications and Management of Foot Ulcers in Patients with Diabetes – care plan (available on the UHL intranet as document 56006)

Adult Anticoagulation, Thrombosis and Thromboprophylaxis Policy (available on the UHL intranet as document 25866)

Conversion to subcutaneous insulin

Where possible the conversion to subcutaneous insulin should be managed by the specialist diabetes team, especially for those with newly diagnosed type 1 diabetes. Where this is not possible the following points give some guidance:

1. Restarting subcutaneous insulin for patients on an established insulin regimen

Previous regimen should be restarted

There should be a 30-60 min overlap between administration of subcutaneous dose and discontinuation of iv insulin infusion. This is because the half life of iv insulin is only 3-4 mins and subcutaneous insulin may take considerably longer to be absorbed.

So the chain of events is

- DKA resolved
- Patient starts eating and drinking
- Restart subcutaneous insulin
- Stop IV insulin 30-60mins after sc insulin

2. Patients on Basal Bolus regimen

- **If long acting analogue insulin has been continued** then give injection of fast acting insulin with meal and discontinue iv insulin infusion 30 mins later.
- **If long acting analogue insulin has been stopped** do not stop iv insulin until some form of background/long acting insulin has been given.
 - For example if basal insulin is usually given at bed-time but you wish to re-start subcutaneous insulin in morning, give ½ basal dose at breakfast with usual rapid acting insulin. Stop iv insulin infusion 30 mins later and continue with usual insulin regimen (e.g. normal meal time doses of rapid acting insulin plus the next full dose of long acting insulin may be given as usual).

3. Patients on twice daily mixed insulin

Re-introduce subcutaneous insulin before breakfast or evening meal and discontinue iv insulin infusion 30 mins after subcutaneous dose given.

4. Patient on Continuous Subcutaneous Insulin Infusion (CSII)

Restart normal basal rate if CSII pump has been disconnected. Stop iv insulin infusion when meal bolus is given (with 30 minute overlap). Do not recommence CSII at bed-time. CSII pump may be continued at the basal rate during the treatment of DKA and in such instances, disconnect the iv insulin infusion 30 mins after meal time bolus given via CSII.

5. Newly diagnosed type 1 diabetes.

Initiation of a subcutaneous insulin regimen should be managed by specialist diabetes team. However if not available it is safe to prescribe either Novomix 30 Flexpen or Humulin M3 Kwikpen (depending on what is available), 10 units in the morning plus 10 units in the evening pending review on the next working day by the Diabetes Specialist Team.

Referral guidelines for the Diabetes Specialist Team

The following recommends when to refer to the diabetes specialist team:

Referrals to Diabetes Specialist Nurses are made via iCM (patient will be seen within 24hours of receiving referral, as long as this falls within normal working hours)

Referral to the on-call Diabetes SpR is via bleep 4264.

Both available Mon-Fri (9am-5pm). **There is no out of hours diabetes on-call team.**

1. Always refer to Diabetes Specialist Nurse:

- a) Newly diagnosed Type 1 diabetes
- b) Newly diagnosed Type 2 diabetes
- c) Patients known to have diabetes admitted with:
 - i. DKA
 - ii. HHS (previously known as HONK)
 - iii. ACS
 - iv. Intravenous insulin infusion with poorly controlled blood sugar
 - v. Intravenous insulin infusion for > 48 hours
 - vi. Severe hypoglycaemia
 - vii. Foot ulceration (see below)
 - viii. Sepsis
 - ix. Persistent vomiting
 - x. Impaired consciousness
 - xi. Inability to self manage diabetes
 - xii. Urgent or major elective surgery
 - xiii. Parenteral or enteral nutrition
- d) Previous problems with diabetes as an inpatient
- e) Patient request

2. Referral may be required:

- a) Intravenous insulin infusion with good control
- b) NBM > 24
- c) Significant educational need
- d) Persistent hyperglycaemia
- e) Possible type 2 diabetes
- f) Stress hyperglycaemia
- g) Poor wound healing
- h) Hyperglycaemia suspected as resulting from Steroid therapy

3. Referral not usually required:

- a) Minor self treated hypoglycaemia
- b) Transient hyperglycaemia
- c) Simple educational need
- d) Routine dietetic advice
- e) Well controlled diabetes
- f) Good self management skills
- g) Routine diabetes care

4. Foot Ulceration

Consider whether urgent surgical review is required e.g. evidence of palpable gas within the tissues or visible on xray, evidence of an abscess, extensive spreading soft tissue infection or critical ischaemia. For information on the 'Prevention of foot complications and management of foot ulcers in patients with diabetes' please see the care plan available on the intranet (see reference section).

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