1. Introduction

1.1 This document sets out the University Hospitals of Leicester (UHL) guidelines for the management of Diabetic Ketoacidosis (DKA) in adults. It is based on the Joint British Diabetes Societies (JBDS) guideline 'The Management of Diabetic Ketoacidosis in Adults' (Revised June 2021).

1.2 There are some key recommendations that were included in the 1st edition of the JBDS Management of DKA (2010) which may differ from historic guidance, these 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 (FRII) based on patient's weight rather than variable (sliding scale) rate

1.3 Changes included in the subsequent version of UHL guidance for the Management of Diabetic Ketoacidosis in Adults taken from the JBDS (2013) include:

a) If patients are already on NPH insulin (Humulin I®, Insulatard® or Insuman Basal®) these insulins should be considered for continuation, in the same way that long acting analogue insulins are continued [see 1.2d above]

b) A maximum initial rate of 15 units per hour of insulin is recommended

c) Patients presenting with newly presenting type 1 diabetes should be initiated on background basal insulin (Levemir®) alongside the FRII. See Section B (covering the 60 mins-6 hours time period), Action 4. Diabetes team should be involved.

1.4 This updated guidance has the new recommendations based on JBDS-IP guideline, 'The management of DKA in Adults: Revised July 2021" and include the following changes:

a) When the glucose concentrations drops to ≤14.0 mmol/L **consider** reducing the rate of intravenous insulin infusion (from 0.1 unit/kg/hour to 0.05 units/kg/hour) to minimise the risk of developing hypoglycaemia and / or hypokalemia.

b) Additional guidance on management of euglycaemic DKA in those treated with SGLT-2 inhibitors (see section 1.9.1), Immune checkpoint inhibitors (1.9.2) and management of DKA in those on Hemodialysis (see section 1.9.3).

c) The expansion of the age group for which this guideline can be used if they are looked after by adult diabetes teams – i.e. for young people aged 16-18 years. Where young people aged 16-18 years are managed by adult medical teams, it is considered appropriate for them to be managed using adult DKA guidelines that the teams are familiar with rather than using potentially unfamiliar paediatric guidelines. Where individuals aged 16-18 years are managed by paediatric teams the paediatric guidelines should be followed.

1.5 The fundamental principles in the management of DKA are:

- Restoration of circulatory volume
- Clearance of ketones with insulin treatment
- Monitoring and maintaining electrolyte / potassium balance in a safe environment.
- Avoiding complications of treatment

1.6 Previous audit of DKA management at UHL has highlighted the potential risks of **hypoglycaemia** and/or **hypokalaemia**. At particular stages of the management pathway extra care is therefore recommended. These risks should be assessed throughout the entire management of DKA however the times when they are considered particularly relevant are highlighted in the treatment pathway below (Section 3) with a warning triangle. ⚠

These include:

- When blood glucose level drops to < 14 mmol/L. If there is a delay in starting the 10% glucose infusion, hypoglycaemia becomes a risk.
- When blood ketones < 0.6 mmol/L. If there is a delay in stopping the fixed rate intravenous insulin infusion (in favour of either variable rate insulin infusion or s/c insulin regimen) hypoglycaemia is a risk.
- At the 1-hour potassium level check, assess the need to add potassium to IV fluid regimen. Audit shows previously some patients who required potassium did not receive it at this point in treatment and became hypokalaemia.

1.7 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
c) Adult Respiratory Distress Syndrome (ARDS)
d) Co-morbid conditions (e.g. pneumonia)
e) Acute MI
f) Sepsis

1.8 Caution: patients with type 1 diabetes who are unwell are at risk of developing DKA particularly if:

- NBM
- Insulin doses are inadequate or omitted.

If a patient with type 1 diabetes deteriorates in hospital, refer for urgent medical review via Nerve Centre or escalate via Medical SpR on-call for urgent review.

1.9 Management of DKA in patients on SGLT2i, Immune checkpoint inhibitors, end stage renal failure/HD and in ketosis prone type 2 diabetes.

1.9.1 Risk of euglycaemic DKA has recently been identified with the use of the class of

oral hypoglycaemic agents 'SGLT-2 inhibitors. If any patient on an SGLT-2 inhibitor (e.g. dapagliflozin, canagliflozin, empagliflozin, ertugliflozin, sotagliflozin) appears unwell, please consider DKA, even if the blood glucose level is not significantly elevated. This condition is treated in exactly the same way as hyperglycemic DKA.

- Initiate glucose 10% straight away at 125 ml/hr because the glucose is <14 mmol/L
- Begin with 0.1units/kg/hr insulin rate.
- If glucose falling despite 10% glucose, reduce insulin rate to 0.05 units/kg/hr to avoid hypoglycaemia

1.9.2 Immune checkpoint inhibitors (ICP), such as cytotoxic T-lymphocyte associated protein 4 (CTLA-4)(e.g.,Ipilumumab, Combination ICP) and programmed cell death protein 1 (PD-1) inhibitors (e.g., Nivolumab, Pembrolizumab) may induce de novo diabetes, although this occurs at a low frequency (<1%). Individuals are at risk of ICP-induced precipitous hyperglycaemia that behaves like new-onset type 1 diabetes, and frequently presents as diabetic ketoacidosis. Almost all individuals require commencement of insulin therapy - early/prompt referral to the diabetes team is required. It has been demonstrated that up to 75% of people who develop ICP-induced hyperglycaemia/diabetes present with diabetic ketoacidosis (DKA).

- Urgent admission and treatment initiation as per trust policy is necessary when DKA or HHS is diagnosed.
- Check Pancreatic antibodies (eg. GAD65, Zn transporter 8 or anti-islet cell)[3]
- People with new onset ICP-induced insulin deficiency often have labile glucose control, and therefore they should be counselled on the risks and symptoms of hypoglycaemia. More relaxed glucose targets may be required to avoid hypoglycaemia wherever possible.
  Immune checkpoint inhibitors can also induce hypopituitarism leading to secondary adrenal insufficiency in most cases (Refer to local immunotherapy related toxicity guidelines for management). Secondary (rarely primary) adrenal insufficiency may lead to hypoglycaemia. Refer to management of hypoglycaemia in adult patients.

1.9 Management of DKA in people with end stage renal failure or on dialysis : Fortunately this is a relatively rare occurrence. There are limited data on the management of DKA in this circumstance. The lack of renal insulin clearance means that DKA is much less likely to occur. It may also be difficult to determine because of the chronic metabolic acidosis associated with advanced chronic kidney disease. When DKA does occur in end stage renal disease, **please liaise with renal team for guidance**. The following aspects of management needs to be considered,

- Fluid replacement: The inability to develop an osmotic diuresis means that dialysis associated hyperglycaemia and ketosis can occur without much dehydration. A mixed picture of DKA and HHS may also occur because of the high serum tonicity. There may be no need for fluid replacement in those with end stage renal failure or those on dialysis. However, for those who are deemed hypovolaemic, aliquots of 250 ml (0.9% sodium chloride or 10% dextrose) may be given with frequent clinical assessments.
- Insulin treatment: For people with end stage renal failure or those on dialysis, insulin replacement is the mainstay of treatment. This should be given as a FRIII at an initial rate of 0.1 units/kg/hr, but may need to increase if the required rate of glucose fall is not achieved. However, the failure to renally clear insulin increases the risk of hypoglycaemia. However, the rate of glucose reduction is the same as for people with preserved renal function – i.e. 3.0 mmol/L/hour. If the rate of fall is faster, or the glucose falls to <14.0 mmol/L strongly consider reducing the rate of intravenous insulin infusion

to 0.05 units/kg/hr.

- Potassium Potassium supplementation is not usually required because the lack of the osmotic diuresis means that there is significantly less potassium loss that for those with preserved renal function. However, the acidosis may lead to significant hyperkalaemia, and this is more common in those with renal failure. In this circumstance, continuous cardiac monitoring is essential and critical care or the specialist renal team should be.

1.9.4 Ketosis prone type 2 diabetes

DKA does not exclusively occur in people with type 1 diabetes. People with type 2 diabetes may also develop DKA – so called 'ketosis prone type 2 diabetes. This most often occurs in people of Afro-Caribbean or Hispanic descent. The treatment for this condition is the same as for others with DKA, but they often come off insulin quickly after the resolution of the DKA and underlying precipitating condition.

Differential diagnosis it is important to exclude other cause of ketoacidosis, such as alcoholic ketoacidosis and starvation ketosis. Ketoacidosis without a raised glucose in a person with alcoholism is virtually diagnostic of alcoholic ketoacidosis.

Starvation ketosis occurs over a prolonged period hence renal compensation for the acidosis means that (as long as other nutrients are eaten) acid base and electrolyte disturbances are often minimal.

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 Acute Care Bay (ACB) on medical admissions ward. 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 3.4 below for advice regarding provision of care.

3 Recommendations, Standards and Procedural Statements

Definitions

3.1.1 **Diabetic ketoacidosis (DKA)** is defined as the accumulation of ketone bodies in the blood of patients with diabetes mellitus, which results in metabolic acidosis. This is indicative of acute metabolic decompensation and is a medical emergency.

3.1.2 **Diagnosis of DKA** may be confirmed by:

- Ketonaemia ≥ 3.0 mmol/L **or** significant ketonuria (more than 2+ on standard urine sticks)
- Blood glucose > 11.0 mmol/L **or** known diabetes mellitus
- Bicarbonate (HCO_3^-) < 15.0 mmol/L **and / or** venous pH < 7.3

3.1.3 **Resolution of DKA** is defined as:

- pH > 7.3

  And

- Blood ketone level < 0.6 mmol/L

3.2 Establishing the diagnosis of DKA

3.2.1 The diagnostic criteria for DKA are as follows, ALL three of the following should be present:

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

3.2.2 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 if:

a) Blood ketones greater than 6mmol/L
b) Bicarbonate less than 5mmol/L
c) Venous / arterial pH less than 7.0
d) Hypokalaemia (less than 3.5mmol/L) on admission
e) GCS less than 12 or abnormal AVPU or NEWS* >6
f) Oxygen saturation less than 92% (assuming normal respiratory baseline)
g) Systolic BP less than 90mmHg
h) Pulse greater than 100 or less than 60 bpm
i) Anion gap greater than 16 N.B. Anion gap = (Na + K) – (Cl + HCO3)

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

Special considerations

3.3.1 Serious complications may arise during the management of DKA as a result of treatment. These include:

a) Hypo or hyperkalaemia

b) Hypoglycaemia

c) Cerebral oedema

d) Pulmonary oedema

3.3.2 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.

3.3.3 Groups of patients in whom extra caution is required in their care and management, particularly regarding fluid balance include:

a) Young people aged 16-25 years

b) Elderly (>70yrs)

c) 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)

d) Cardiac or renal failure

e) Other serious co-morbidities

3.4 Provision of care for patients with DKA

3.4.1 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 medical admission ward, LRI or if clinically indicated, to ITU. If patients require stepdown from ACB to a medical ward, this should be to a suitable medical ward and should be discussed with Diabetes SpR, Diabetes specialist in-reach team or medical SpR on-call.

3.4.2 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 NEWS indicates or directly after clerking and initiation of treatment by a junior member of the team if NEWS does not indicate immediate senior review is required.

3.4.3 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.

3.4.4 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.

3.4.5 If DKA develops outside of the ED or ACB then once immediate treatment has been initiated by the ward team 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.

3.4.6 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

(See Section 3.2).

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

Time = 0 mins at time intravenous (iv) fluids are commenced. If access problems, involve critical care support immediately.

- Commence IV 0.9% sodium chloride
- Give 10 units soluble insulin (e.g. Actrapid®) stat either i/m or s/c if likely to be delay of longer than 15 mins from diagnosis, in starting iv insulin (See Action 1 below)
- 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
- Consider Level 2/HDU if criteria for severity are met (3.2.2)

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

- Assess Airway, Breathing, Circulation and **NEWS**
- Site Large bore iv cannula
- Commence fluid replacement (for Regimen see Action 2 below)
- Give 10 units soluble insulin (e.g. Actrapid®) stat either i/m or s/c if there is likely to be a delay of longer than 15 minutes from diagnosis in starting iv insulin. If fixed rate IV insulin can be started within 15 mins, omit this stat i/m or s/c insulin dose.
- Clinical assessment (RR, Temp, BP, Pulse, O_2 sats, NEWS 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 **and** perform pregnancy test if appropriate

Action 2 – restoration of circulating volumes 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

DKA Care Pathway

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), pregnancy, those with renal / cardiac failure and other serious co-morbiditues Level 2/ HDU should be considered. 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.

 Assess potassium levels. Add potassium to IV fluids if required as risk of hypokalaemia

	Fluid	**Volume over time**	**Rate** (ml/hr)
1st Litre	0.9% sodium chloride *	1000ml over 1 hr	1000
2nd Litre	0.9% sodium chloride +/- potassium chloride	1000ml over next 2 hr	500
3rd Litre	0.9% sodium chloride +/- potassium chloride	1000ml over next 2 hr	500
4th Litre	0.9% sodium chloride +/- potassium chloride	1000ml over next 4 hr	250
5th Litre	0.9% sodium chloride +/- potassium chloride	1000ml over next 4 hr	250
6th 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**
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 Check blood glucose levels, as risk of hypoglycaemia if 10% glucose not started when capillary blood glucose falls below 14 mmol/L. When the glucose concentrations drops to ≤14.0 mmol/L consider reducing the rate of intravenous insulin infusion to 0.05 units/kg/hour to reduce the risk of developing hypoglycaemia and / or hypokalaemia.

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. NB: rate of sodium chloride infusion will need changing when 10% glucose infusion used in addition (see eg 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

DKA Care Pathway

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 normally uses NPH [intermediate acting] insulin (Humulin I®, Insulatard® or Insuman Basal®) or long acting analogue insulin (Lantus®, Abasaglar®, Levemir®, Toujeo® or Tresiba®) subcutaneously then continue this at usual time and dose as well as above IV regimen.

Commence insulin infusion at the following rate of 0.1unit/kg/hr[$].

Intravenous insulin infusion is made up as 50 units of Human Soluble insulin diluted to 50ml with normal saline and given at a rate determined by the patient's weight (0.1unit/kg/hr).

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

[$]N.B. A **maximum** initial rate of 15 units per hour of insulin is recommended

Action 4 – senior review

It is most important that patients with DKA are reviewed by a medical SpR/Consultant immediately if NEWS 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 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 3.2.2 for indicators of severe DKA.

DKA Care Pathway

Section B (60 mins-6 hours)

Aims

- Clear the blood of ketones and suppress ketogenesis
- Achieve rate of fall of blood ketones of 0.5mmol/hr or rise in bicarbonate of 3mmol/L/hr
- Fall in blood glucose by 3mmol/L/hr until level is below 11 mmol/L
- Maintain serum potassium in normal range
- Avoid hypoglycaemia
- **Ensure that senior review by SpR or Consultant been undertaken**

Action 1 – reassess the patient and monitor

- Review hourly initially, to ensure adequate progress in reducing ketones and/or glucose levels is being made
- Consider urinary catheter if incontinent or not passed urine
- Consider NGT if reduced conscious level or persistent vomiting
- If oxygen sats falling then perform arterial blood gas, repeat CXR and give O_2
- Ensure regular vital signs and NEWS charting and review
- Ensure accurate fluid balance charting (minimum urine output 0.5ml/kg/hr)
- Cardiac monitoring for those with severe DKA
- Assess risk for VTE and give LMWH as per UHL guidelines (see ref 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
    - if meter reads "HI" for either ketones or glucose then venous blood should be sampled in lab or using blood gas analyser
- Review whether blood ketones are falling satisfactorily (at least 0.5 mmol/hr) – 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.

DKA Care Pathway

- 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*)
- In addition consider reducing the rate of intravenous insulin infusion to 0.05 units/kg/hr.

**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).*

 Risk of hypoglycaemia if 10% glucose not started when capillary blood glucose falls below 14mmol/L.

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).

Action 4 – for those with newly diagnosed type 1 diabetes initiate long-acting (Levemir®) insulin (with involvement of diabetes team wherever possible).

Prescribe and administer Levemir® insulin at a minimum dose of 0.25 units/kg s/c at initiation. The total dose can be given either once daily or split to twice daily. This will help to mitigate against rebound ketones when IV insulin stopped.

A simple guide to recommended doses prior to discharge is as follows based on weight:

< 50kg – 5 units of Levemir insulin BD 50-

80kg – 10 units of Levemir insulin BD

> 80kg – 15 units of Levemir insulin BD

This is a starting dose and is likely to require titration with involvement of the Diabetes Team. If a patient is discharged without review by the diabetes team (eg at weekend) ensure referral is made for urgent contact and review by diabetes team within 48 hrs of discharge.

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 – reassess the patient and 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 electronic referral (via ICE) is made to diabetes team– 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 < 0.6 mmol/L, venous pH > 7.3
• 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**  risk of hypoglycaemia if fixed rate insulin infusion not switched to variable rate insulin infusion or s/c insulin regimen when blood ketones < 0.6 mmol/L. (See Appendix A for advice on switching to s/c insulin).
• **If DKA not resolved refer back to Section B Action 2**

DKA Care Pathway

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 (< 0.6 mmol/L) change to UHL IV variable rate insulin regimen (details on green insulin prescribing and monitoring chart)
-  risk of hypoglycaemia if fixed rate insulin infusion not switched to variable rate insulin infusion when blood ketones < 0.6 mmol/L. Note: substrate fluid of 5% glucose will be required if patient is switched to variable rate insulin infusion
- 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 – reassess the 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
    - Resolution of DKA defined as blood ketones < 0.6 mmol/L, venous pH > 7.3
    - Do not use bicarbonate as surrogate marker at this stage
        - NB Hyperchloraemic acidosis can occur secondary to high volumes of 0.9% sodium chloride

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 s/c insulin, see guidance in Appendix A
Action 2 – referral to specialist diabetes team via ICE 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 Nurse Helpline (ext. 4919) 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 via LRI switchboard

2. Education and Training

2.1 It is expected that all registered staff working in the Emergency Department (ED), LRI admissions (Acute Care Bay [ACB] 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 Insulin Safety training (accessed via HELM) and familiarised with this guidance.

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.

3. 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 periodically. As a minimum 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 data is submitted centrally, analysed and fed back to the Trust.

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

4. Supporting Documents and Key References

UHL guidelines for:

1. Management of Hypophosphatemia (available on the UHL intranet)
2. The Management of Diabetic Ketoacidosis in Adults, Joint British Diabetes Societies (JBDS), July 2021
3. The Management of Glycaemic Control in Patients with Cancer Guidance for the diabetes and oncology multidisciplinary teams Report of a working party on behalf of the UK Chemotherapy Board and Joint British Diabetes Societies for Inpatient Care May 2021

5. Key Words

Diabetic ketoacidosis

DKA

Ketosis

Ketone

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Type 1

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REVIEW RECORD			
Date	**Issue Number**	**Reviewed By**	**Description Of Changes (If Any)**
		Helen Atkins Fiona Adlam	Amended in line with national guidance (JBDS, 2021) Most significant amends are included in section 1.4 of guidance

DISTRIBUTION RECORD:			
Date	**Name**	**Dept**	**Received**

Appendix A

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 (see point 5 below). 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 (if patient was on a long / intermediate acting insulin, this should already have been continued as part of the routine DKA management protocol.) The guidance below covers the both scenarios of long acting or intermediate acting insulin having been continued, or not. (See 2a and 2b below).
There should be a 30-60 min overlap between administration of subcutaneous dose (of mixed insulin or mealtime 'bolus' insulin) 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 (see below for timings)
- Stop IV insulin 30-60mins after s/c insulin

2. Patients on Basal Bolus regimen

a) **If long acting or intermediate acting (aka NPH) insulin has been continued** then give injection of fast acting (meal time) insulin with next meal and discontinue iv insulin infusion 30 mins later.

b) **If long acting or intermediate acting (aka NPH) 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

According to the UHL DKA management pathway, initiation of a long acting subcutaneous basal insulin (Levemir®) should have occurred in Section B, Action 4. Ideally this should be managed with help from a specialist diabetes team. However if team not available and s/c insulin has not yet been started it is recommended:

Prescribe and administer Levemir® insulin at a minimum total dose of 0.25 units / kg s/c. The total dose can be given either once daily or split to twice daily. This will help to mitigate against rebound ketones when IV insulin stopped.

A simple guide to recommended doses prior to discharge is as follows based on weight:

< 50kg – 5 units of Levemir insulin BD 50-

80kg – 10 units of Levemir insulin BD

> 80kg – 15 units of Levemir insulin BD

This is a starting dose and is likely to require titration with involvement of the Diabetes Team. If a patient is discharged without review by the diabetes team (eg at weekend) ensure referral is made for urgent contact and review by diabetes team within 48 hrs of discharge.

Appendix B

Referral guidelines for the Diabetes Specialist Team

- Electronic referrals to Diabetes Specialist Nurses are made via ICE (patient will be seen within 24hours of receiving referral, as long as this falls within normal working hours)
- The Diabetes Specialist Nurses may also be contacted via the 'Diabetes Nurse Helpline' on x 14919
- Referral to the on-call Diabetes SpR may be made via the LRI switchboard.

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

Diabetes referral criteria are detailed on ICE

ADULT DIABETIC KETOACIDOSIS PRESCRIPTION CHART

NHS
University Hospitals of Leicester
NHS Trust

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	1000 / other *.....				
	Sodium chloride 0.9% 500ml/30mins					

*** 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, Action 2 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	500 /	Nil / 20mmol in				
	Sodium chloride 0.9% 500ml/hr	other……..	500ml other…….				
3rd Litre over 2hrs	Sodium chloride 0.9% 500ml/hr	500 /	Nil / 20mmol in				
	Sodium chloride 0.9% 500ml/hr	other……..	500ml other…….				
4th Litre over 4hrs	Sodium chloride 0.9% 500ml/2hrs	250 /	Nil / 20mmol in				
	Sodium chloride 0.9% 500ml/2hrs	other……..	500ml other…….				
5th Litre over 4hrs	Sodium chloride 0.9% 500ml/2hrs	250 /	Nil / 20mmol in				
	Sodium chloride 0.9% 500ml/2hrs	other……..	500ml other…….				
6th Litre over 6hrs	Sodium chloride 0.9% 500ml/3hrs	166 /	Nil / 20mmol in				
	Sodium chloride 0.9% 500ml/3hrs	other……..	500ml other…….				
7th Litre over 6hrs	Sodium chloride 0.9% 500ml/3hrs	166 /	Nil / 20mmol in				
	Sodium chloride 0.9% 500ml/3hrs	other……..	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

⚠ **Risk of hypoglycaemia if fixed rate IV insulin is not switched to variable rate insulin infusion or S/C insulin once blood ketones < 0.6mmol/L.**

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

⚠ **Risk of hypoglycaemia. 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. Additionally, when the glucose concentrations drops to ≤14.0 mmol/L consider reducing the rate of intravenous insulin infusion to 0.05 units/kg/hour to reduce the risk of developing hypoglycaemia and / or hypokalaemia

	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 ⚠ **Risk of hypokalaemia** if potassium not added to IV fluids
Below 3.5	Senior review, since additional potassium needs to be given

3) INSULIN (Human soluble insulin e.g. Human Actrapid)

Give stat dose of soluble insulin either s/c or i/m ONLY if likely to be a delay > 15 mins in starting fixed rate IV insulin infusion. 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 (Max dose of 15 units per 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, Abasaglar, Levemir, Tresiba,Toujeo) or NPH insulin (Insulatard, Humulin I, Insuman Basal) 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 (assess need)					
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					

*For 16-18 year olds use this guideline if managed by the adult diabetes team but if managed by the paediatric team follow paediatric DKA guidelines
Adapted from chart used at Countess of Chester Hospital NHS Foundation Trust

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ADULT DIABETIC KETOACIDOSIS-PRESCRIPTION CHART

1

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 and/or venous pH <7.3

NB. Risk of euglycaemic DKA has been identified with use of SGLT-2 inhibitors (dapagliflozin, canagliflozin, empagliflozin, ertugliflozin, sotagliflozin). See full guidance 1.9

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 (ONLY if likely to be a delay > 15 mins from diagnosis, in starting fixed rate IV insulin infusion)
- 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 7.0
- Hypokalaemia on admission (below 3.5mmol/L)
- Anion gap above 16 [$(Na^+ + K^+) – (Cl^- + HCO3^-)$]
- GCS less than 12 or abnormality on AVPU scale or EWS > 6
- 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	**Commence 0.9% sodium chloride infusion via infusion pump** • Systolic BP on admission above 90 mmHg Prescribe fluids and follow fluid replacement schedule on page 1 • Systolic BP on admission below 90 mmHg 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 (ONLY if delay > 15 mins from diagnosis, in starting IV insulin infusion)**
Action 4	**Potassium replacement** ⚠ 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.
Action 5	**Commence fixed rate intravenous insulin infusion (IVII)** 0.1unit/kg/hr based on actual or estimated weight - prescribe on page 1 (Max dose of 15 units per hour) Use 50units human soluble insulin (Actrapid) in 50ml sodium chloride 0.9% If patient usually takes long-acting insulin analogue (Lantus, Abasaglar, Levemir, Tresiba,Toujeo) or NPH insulin (Insulatard, Humulin I, Insuman Basal) then continue at usual dose and time Insulin may be given through same line as iv fluids using a Y connector.
Action 6	**Complete full history and clinical examination** Consider ITU/HDU if above guidelines indicate severe DKA
Action 7	**Consider further investigations** CXR, ECG, MI screen, MSU, blood cultures
Action 8	**Establish monitoring regimen and ensure senior review occurs (SpR / Consultant)** Use 24 hour DKA monitoring form on page 4 Capillary glucose, U&Es (including venous bicarbonate and potassium) to be repeated at 60 minutes ⚠ Replace potassium appropriately Continuous pulse oximetry and cardiac monitoring if required
Action 9	**Prescribe thromboprophylaxis on main drug chart - if indicated** **Consider precipitating cause and treat appropriately**
Action 10	**Refer to Diabetes Team** Diabetes nurses may be contacted by electronic referral via ICE or DSN helpline x4919; diabetes SpR available during normal working hours via LRI switchboard
Action 11	**Ward location and supervising consultant** Patients should be managed initially on the AMU in the Acute Care Bay (unless ITU/HDU bed required). If patients require stepdown from ACB to a suitable medical ward and this should be discussed with Diabetes SpR / Diabetes specialist in-reach team or medical SpR on-call).
Action 12	**Intravenous bicarbonate is very rarely necessary** If pH <7.0 and not improving contact critical care team

BOX B: Management from 60 minutes to 6 hours	
Aims	• 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 3 mmol/L/hr (until level is below 11 mmol/L) • Maintain serum potassium in normal range • Avoid hypoglycaemia
Action 1	**Re-assess patient and continue to monitor vital signs - ensure that patient has had a senior review (SpR / Consultant)** • 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, give O_2 • Document accurate fluid balance including urine output (minimum desired output = 0.5ml/kg/hr)
Action 2	**Review metabolic parameters** • Measure and record hourly capillary blood glucose (lab glucose if meter reading 'HI') and blood ketone levels • 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 in first 6 hours • Complete DKA monitoring chart on Page 4 for all monitoring parameters.
Action 3	**Assess response to treatment with insulin infusion, rate may need review if:** • 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 (until < 0.6 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 >15 mmol/L and/or blood ketones <0.6 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	**Continue fluid and potassium replacement via infusion pump** • Follow fluid replacement schedule on Page 1 - when blood gluscose is less than 14mmol/L **add** 10% glucose at 125 ml/hr to run alongside 0.9% sodium chloride - review fluid prescription to avoid fluid overload. **In addition consider reducing the rate of fixed rate intravenous insulin infusion to 0.05 units/kg/hr.** • If potassium outside reference range, re-assess potassium replacement (as page 1) and check hourly. If abnormal after further hour seek senior medical advice.
Action 5	**For those with newly diagnosed Type 1 diabetes** • Prescribe and administer Levemir® insulin at a minimum total dose of 0.25 units/kg s/c. The total dose can be given either once daily or split to twice daily. This will help to mitigate against rebound ketones when IV insulin stopped. See full DKA guidance for advice on discharge doses.

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	• 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	**Re-assess patient, monitor vital signs** • If patient not improving seek senior advice • Ensure referral made to Diabetes team - Diabetes nurses may be contacted electronically via ICE or contact diabetes SpR during normal working hours via LRI switchboard
Action 2	**Review biochemical and metabolic parameters** • At 6 hrs check venous pH, potassium, bicarbonate and glucose • Resolution of DKA defined as venous pH >7.3 and blood ketones <0.6 mmol/l (do not use bicarbonate as a surrogate marker at this stage) • If DKA not resolved refer to Action 3 in Box B	**Review biochemical and metabolic parameters** • At 12, 18 and 24 hrs check venous pH, potassium, bicarbonate and glucose • Resolution of DKA defined as venous pH >7.3 and blood ketones <0.6 mmol/l (do not use bicarbonate as a surrogate marker at this stage) • If remains acidotic (pH<7.3 and/or HCO3 <15 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, contact diabetes SpR via LRI switchboard
Action 3	When DKA resolved review insulin infusion to maintain capillary glucose 5-10 mmol/l and switch back to subcutaneous insulin when eating and drinking. (Use a **variable rate** insulin infusion if not eating / drinking). 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.	

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: Blood ketones <0.6mmol / L and pH > 7.3

Date:																									
Hours from start		**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**
Clock time																										
Capillary Glucose (mmol/L) (measure hourly and plot result on graph)	40																									
	30																									
	20																									
Start 10% glucose when glucose <14mmol/L and reduce FRIII to 0.05 units/kg/hr →	15																									
⚠ **Hypo risk if 10% glucose not started promptly**	10																									
	5																									
Insulin (0.1 unit/kg/hr)**(units/hr)**																										
Insulin (0.05 units/kg/hr)																										
0.9% sodium chloride (ml/ hour)																										
10% glucose (ml/ hour)																										
Blood ketone																										
Venous pH ⚠																										
Venous Potassium (mmol/L)																										
Venous Bicarbonate (mmol/L)																										