1. Introduction

1.1 This document sets out guidance for the measurement of blood ketones.

1.2 Ketone testing is required to assist with the diagnosis and management of diabetic ketoacidosis (DKA). Traditionally ketones have been measured in the urine but this testing method has limitations:
   - The patient cannot always pass urine to order
   - Urine continues to show ketones long after ketone production has ceased

1.3 Blood ketone testing is more relevant to clinical practice than urine testing and enables more accurate assessment of the effectiveness of treatment of DKA. Decreasing levels of blood ketones indicates clinical improvement.

2. Scope

This guideline applies to medical staff and qualified nursing staff working in areas where use of blood ketone meters has been implemented and education has been delivered to nursing staff in:

- ED, AMU 15 & 16 [LRI]
- Labour wards [LRI & LGH]
- Diabetes wards [LRI]
- Renal ward 15A [LGH]
- CDU [GGH]

This guideline applies to adult patients with suspected or confirmed DKA. **Note: this guideline applies only to the use of blood ketone meters. The document should be used in conjunction with the UHL Guidelines for the Management of Diabetic Ketoacidosis (DKA) in Adults.**

3. Recommendations, Standards and Procedural Statements

3.1 Definitions

**Ketones** are organic compounds that result when body fat is broken down for energy. In the absence of insulin this process occurs excessively and can produce enough ketones to cause toxicity.

**Diabetic ketoacidosis (DKA)** is defined as the accumulation of ketone bodies (ketones) in the blood of patients with diabetes mellitus, which results in metabolic acidosis.

3.2 When to do Blood Ketone Measurements:

- To establish the diagnosis of DKA
- In the treatment of diagnosed DKA
### 3.3 Treatment Table based on the Blood Ketone Result (to be used in conjunction with UHL guidelines for the Management of Diabetic Ketoacidosis (DKA) in Adults)

<table>
<thead>
<tr>
<th>Blood ketone levels</th>
<th>Action in DKA</th>
<th>Action in patients with type 1 diabetes and blood glucose levels &gt; 15mmol/L* who are risk of DKA</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; 3 mmol/L</td>
<td>Monitor one hourly. It is expected that blood ketone levels will reduce by 0.5mmol/l per hour. If this is not being achieved ask a Doctor to review management. Refer to UHL guidelines</td>
<td>Monitor hourly and refer to the medical team for assessment for DKA. Refer to UHL guidelines</td>
</tr>
<tr>
<td>1.6-3.0 mmol/L</td>
<td>Continue to monitor two hourly</td>
<td>Refer to medical staff for assessment for DKA. Re-test blood glucose and ketones in two hours</td>
</tr>
<tr>
<td>0.6-1.5 mmol/L</td>
<td>Continue to monitor 4 hourly until the patient is eating and drinking and the patient is back on a subcutaneous insulin regimen. Resume testing for blood ketone levels. If blood glucose level is &gt; 15mmol/L</td>
<td>Re-test blood glucose and ketones two hourly. Report to medical staff if the ketone levels do not fall as the patient’s insulin dose may need reviewing.</td>
</tr>
<tr>
<td>0.0-0.6 mmol/L</td>
<td>Revert to routine blood glucose monitoring</td>
<td>Retest for blood ketones only if the blood glucose levels are &gt; 15mmol/L*</td>
</tr>
</tbody>
</table>

* If patient is on an SGLT-2 inhibitor (dapagliflozin, canagliflozin, empagliflozin) there is a reported risk of euglycaemic DKA. Blood glucose levels may not be overtly raised, so do not rely on raised blood glucose levels to make a diagnosis of DKA in these patients.
3.4 Quality Control (QC)

- All machines will have an accompanying log book to record quality control results
- Quality control solutions can be obtained by contacting Pathology Lab LRI one bottle to be opened and dated and discarded after 3 months from opening or the expiry date. Only ONE QC solution will be in use in one 3 month period
- Blood ketone meters must be quality controlled
  - Weekly
  - When a new pot of ketone test strips is calibrated
  - When the battery has been changed
  - After an error message or unexpected result
- The label on the QC solution will indicate acceptable ranges for both solutions. The results should be in these ranges, and documented in the log book. If these are in the acceptable range the meter is and test strips are working correctly
- Ranges can vary from Lot to Lot of the test strips and the QC solution
- If the results are outside the range:
  - Repeat the test
  - Contact medical staff on call for your area
  - Revert to urine ketone testing

3.5 Meters

In the event of the ketone meter not recording accurately or outside the parameters of the QC testing, the meter must be taken out of operation. All consumables (log book, QC solution) should be returned to Pathology Lab LRI and a new meter should be sought.

In the event of an incident occurring whilst undertaking any part of the process a DATIX form should be completed, as per trust incident policy.

4. Education and Training

Only qualified nursing staff that have received appropriate training in capillary blood ketone testing with the meters provided should undertake blood ketone testing.

Capillary blood ketone training will initially be provided in conjunction with Abbott, and subsequently cascaded to staff via cascade trainers using the Abbott cascade trainer pack. Staff must complete the competencies associated with capillary blood ketone testing.

5. Monitoring and Audit Criteria

<table>
<thead>
<tr>
<th>Key Performance Indicator</th>
<th>Method of Assessment</th>
<th>Frequency</th>
<th>Lead</th>
</tr>
</thead>
<tbody>
<tr>
<td>Report on the meters</td>
<td>Diabetes team members will undertake audit. Results fed back to ward managers</td>
<td>6-monthly</td>
<td>Chair of the DM inpatient steering group</td>
</tr>
</tbody>
</table>
6. Legal Liability Guideline Statement
Guidelines or Procedures issued and approved by the Trust are considered to represent best practice. Staff may only exceptionally depart from any relevant Trust guidelines or Procedures and always only providing that such departure is confined to the specific needs of individual circumstances. In healthcare delivery such departure shall only be undertaken where, in the judgement of the 'responsible healthcare professional' it is fully appropriate and justifiable – such decision to be fully recorded in the patient’s notes.

7. Supporting Documents and Key References
Please refer to the UHL Guidelines for the Management of Diabetic Ketoacidosis (DKA) in Adults.


This guidance relates to diagnosis and management of DKA in adults.

[Adapted from the Joint British Diabetes Societies (JBDS) Management of Diabetic Ketoacidosis in Adults (2013).

Available at: http://www.diabetologists-abcd.org.uk/jbds/JBDS_IP_DKA_Adults_Revised.pdf

8. Key Words
Ketone
Ketosis
Ketoacidosis
DKA

DEVELOPMENT AND APPROVAL RECORD FOR THIS DOCUMENT

<table>
<thead>
<tr>
<th>Author / Lead Officer</th>
<th>Job Title: Diabetes Consultant</th>
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<tbody>
<tr>
<td>Dr Kath Higgins</td>
<td></td>
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Reviewed by: Inpatient Diabetes Steering Committee
Approved by: PGC Chair’s approval
Date Approved: August 2013

REVIEW RECORD

<table>
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<tr>
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<th>Issue Number</th>
<th>Reviewed By</th>
<th>Description Of Changes (If Any)</th>
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<tr>
<td>26/05/16</td>
<td>2</td>
<td>Elizabeth Hackett</td>
<td>Minor and formatting amends Numbers on treatment Table (section 3.3) altered slightly in line with new DKA resolution values (See Guidelines for the Management of Diabetic Ketoacidosis (DKA) in Adults for details)</td>
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<tr>
<td>3.6.16</td>
<td>2</td>
<td>PGC</td>
<td>Approved subject to changes which are now incorporated</td>
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Guideline for Blood Ketone Measurement, Author: Dr Kath Higgins (revised Elizabeth Hackett)
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