Blood Ketone Measurements for Adult Patients with Diabetes UHL Guideline

University Hospitals of Leicester NHS
NHS Trust

Trust ref: B11/2013

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) and in the assessment of the acutely unwell patient with diabetes. Ketone testing may also be required in the management of other conditions, including COVID19, acute abdomen, peri-operative care in people with diabetes and some intoxications. This guideline refers to the management of patients with suspected or confirmed diabetic ketoacidosis.

1.3 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

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

1.5 This guide will assist medical, nursing and midwifery staff to determine appropriate health care for the management of blood ketones for inpatients.

2. Scope

This guideline applies to medical staff, nursing and midwifery employees working in areas where use of blood ketone meters has been implemented and education has been delivered to nursing staff and where applicable a LCAT assessment has been completed.

This guideline applies to adult patients with suspected or confirmed DKA, who are admitted acutely unwell or become acutely unwell whilst in hospital or according to Hyperglycaemia in Adult Inpatients with Diabetes - including Decision Support Tool UHL Guideline Trust reference B27/2019 which is located in the Policies and Guidelines Library). Note: Any patient with covid-19 admitted acutely unwell should have blood glucose on admission. Check ketones in everybody with diabetes being admitted and in everybody with an admission glucose over 12 mmol/l. Diabetes Including Diabetic Ketoacidosis (DKA) and Hyperglycaemia - in Adult Inpatients with COVID-19 UHL Guideline Trust Reference B24/2020 which is also located in the Policies and Guidelines Library.

Note: this guideline applies only to the use of blood ketone meters.

2.1 Areas of responsibility

Heads of Nursing (HoN) and Deputy HoN, Matrons across the Trust are responsible for ensuring this policy is made known to all staff who are required to use it and its use as part of clinical orientation.

All hospital nursing and midwifery staff are responsible for referring to the recommendations

in this guide. Where a clinical area has HCA staff who have undertaken the necessary education, training and LCAT (overseen by ward manager) then the escalation tool should be followed by the trained HCA. With the development of the "diabetes support decision tool (adults)" it is necessary to include HCAs in blood ketone testing. See section 3.

Non-employees e.g. nursing and midwifery students are required to refer to this guide as stated under the supervision of a registered nurse and/or registered midwife.

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
- When assessing a patient with diabetes who is acutely unwell or who has persistent hyperglycaemia (capillary blood glucose >18mmol/l)
- Daily if patient is fasting and known to have type 1 diabetes
- Daily if the patient remains unwell (e.g. systemic illness, infection, febrile, nausea, diarrhoea post fasting not eating and drinking)
- When assessing an acutely unwell patient if there is a risk of new onset DKA/type 1 diabetes (including patients admitted with covid-19 who are acutely unwell)
- Current guidance suggests that SGLT-2i (e.g.,dapagliflozin, canagliflozin, empagliflozin) should be interrupted in people with diabetes who have been hospitalised for major surgery or acute serious illness.
  Please refer to Diabetes Patients Undergoing Surgery UHL Guideline (Guideline for Perioperative Care for People with Diabetes Mellitus Undergoing Elective and Emergency Surgery Trust ref B3/2013).

  Elective surgery:

  1. Updated guidance suggests that SGLT-2i should be interrupted in people with diabetes who have been hospitalised for major surgery or acute serious illness. There is no current consensus on duration of treatment cessation. We recommend stopping SGLT2i three days prior to elective surgery. Longer period of treatment cessation may be necessary in certain circumstances (like Bariatric surgery, patients requiring reduced calorie intake prior to procedures) and, in general, should coincide with the reduced food intake. Please regularly check the UKCPA Handbook of Perioperative Medicines (https://www.ukcpa-periophandbook.co.uk/) for updated advice.
  2. **Check capillary blood ketones daily** if the person with diabetes is normally on SGLT2 inhibitors (gliflozins) even if glucose concentrations are normal (as these medications can be associated with euglycaemic ketosis)
  3. SGLT2i treatment may be restarted once ketone levels are normal and the person with diabetes condition has stabilised, and normal oral intake is established.

Emergency Surgery

1. Withhold SGLT-2 inhibitors on admission to hospital.
2. Ensure all emergency admissions of people with diabetes have glycaemic status (CBG) and metabolic status (renal profile, lactate and **ketones**) documented.
3. **Check ketones daily.**
4. Post-operatively, DO NOT restart SGLT2i until eating and drinking normally, any volume depletion has been corrected, VRIII (where applicable) has been stopped, ketone levels are normal and patient is medically stable. Once restarted check ketones daily whilst an inpatient, even if CBG is normal

- Caution: If a patient is taking an SGLT-2 inhibitor (dapagliflozin, canagliflozin, empagliflozin) or is acutely unwell with covid-19 there is a reported risk of euglycaemic DKA (DKA with normal blood glucose readings). Blood glucose levels may be normal or only slightly raised and so do not rely on raised blood glucose levels to make a diagnosis of DKA in these patients. Test blood ketones in any patient with type 2 diabetes who is acutely unwell as part of their initial assessment

3.3 Notifications and escalation

The table below explains how to escalate diabetes management when monitoring blood ketone levels.

A diabetes treatment review by the medical practitioner should occur as soon as practicable. Avoidable causes should be identified and corrected using the hyperglycaemia decision support tool. If the cause is not identified or cannot be corrected, the patient should be reviewed as a matter of urgency.

3.4 Treatment and escalation table based on the Blood Ketone Result

Blood ketone levels	Action in DKA (treatment initiated according to UHL DKA guidelines)	Action in patients with type 1 diabetes who are unwell and/or CBG > 18mmol/L* or who are risk of DKA
> 3 mmol/L	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 DKA guidelines	Monitor hourly and urgently refer to the medical team for assessment for DKA.
1.6-3.0 mmol/L	Continue to monitor two hourly	Refer to medical staff for assessment for DKA. Re-test blood glucose and ketones in two hours
0.6-1.5 mmol/L	Continue to monitor 4 hourly until the patient is eating and drinking, DKA has resolved and the patient is back on a subcutaneous insulin regimen Resume testing blood ketone levels if CBG is > 18mmol/L	Re-test blood glucose and ketones two hourly. Report to medical staff if patient is unwell and/or the ketone levels do not fall as the patient's insulin dose will need reviewing. Ensure patient is drinking fluids.
0.0-0.6 mmol/L	Revert to routine blood glucose monitoring	Retest for blood ketones only if the blood glucose levels are > 18mmol/L*

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3.5 Suggested variations in blood ketone monitoring for fail and/or elderly patients.

Care plans for older or frail people with diabetes including blood ketone monitoring should be tailored to the individual's needs, functional status, life expectancy and health status using a whole of life approach which encompasses end of life care if indicated. Further information in the management of end of life for people with diabetes can be accessed here. http://insitetogether.xuhl-tr.nhs.uk/pag/pagdocuments/Last%20Days%20of%20Life%20UHL%20Guideline.pdf

Testing frequency should be individualised according to functional status of the

patient and should be assessed on a daily basis if necessary.

4.Education and Training

For all staff, initial training on the glucose / ketone meters is provided by the Nova Biomedical training specialist or POCT approved cascade trainers / educators. Following this training, staff who are band 5 or above will be given access to glucose and ketone testing for 2 years and staff who are bands 2-4 will be given access to glucose testing for 2 years.

There is a Helm eLearning module – 'Glucose/Ketone Meter (eLearning – Helm/Rise)' which must be completed to reinstate access every 2 years thereafter.

With the development of the "diabetes support decision tool (adults)" it is necessary to include HCAs in blood ketone testing. Once trained they will be able to perform blood ketone testing and be confident in the correct use of the ketone blood test strips.

The responsible ward/department manager should ensure the HCA is aware of the ward/dept escalation procedure and who to report to with the blood ketone test result.

HCAs can be given access **only** if they complete and pass the 'Competency Assessment for the testing of blood ketones for HCAs within UHL' – See Appendix 1. Only Trust approved LCAT assessors can submit the assessment to POCT (evidence of LCAT assessor training should be recorded on the staff members Helm account). This role should only be implemented if the ward manager/matron has oversight and ensures the trained HCAs are fully knowledgeable of the 'Health Care Assistant Blood Ketone Test Escalation Tool' – See Appendix 2.

HCAs will be given ketone access for a year and must be re-assessed annually to maintain ketone access thereafter. This assessment will be in addition to the 2 yearly refresher course stated above.

In addition all medical and nursing staff are required to complete essential to role Insulin Safety training. This training can be accessed via HELM and is renewable on a yearly basis.

5.Monitoring and Audit Criteria

Key Performance Indicator	Method of Assessment	Frequency	Lead
Adherence to the guideline	Review of Datix incidents and NaDia harms data	continuous	Helen Atkins and S Setty

6.Supporting Documents and Key References

Please refer to the UHL Guidelines for the Management of Diabetic Ketoacidosis (DKA) in Adults. http://insitetogether.xuhl-tr.nhs.uk/pag/pagdocuments/Diabetic%20Ketoacidosis%20(DKA)%20in%20Adults%20UHL%20Guideline.pdf

UHL Hyperglycaemia Decision support tool http://insitetogether.xuhl-tr.nhs.uk/pag/pagdocuments/Hyperglycaemia%20in%20Adult%20Inpatients%20with%20Diabetes%20-%20including%20Decision%20Support%20Tool%20UHL%20Guideline.pdf

Guideline for Perioperative Care for People with Diabetes Mellitus Undergoing Elective and Emergency Surgery Trust reference B3/2013

4. Key Words

Ketone

Ketosis

Ketoacidosis

DKA

Monitoring

DEVELOPMENT AND APPROVAL RECORD FOR THIS DOCUMENT		
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Appendix 1. Competency Assessment for the testing of blood ketones for HCAs within UHL. LCAT Assessors Recording Form:

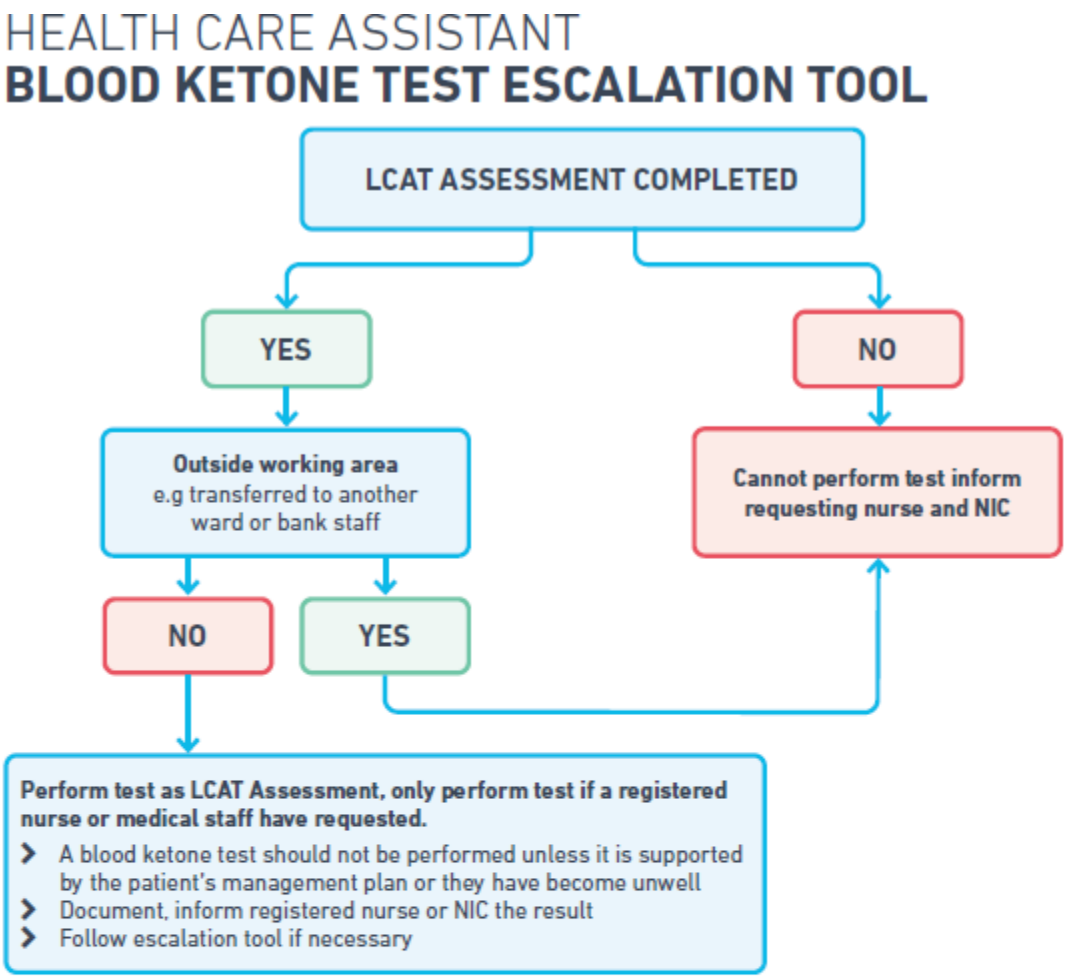
Nurse Name	**Date**	**Nurse Signature**	
Competence Category	Positive Features	Weakness / Omissions	Score
Communication and working with the patient	• Introduces self to the patient • Explains the procedure • Gains and maintains Consent		
Safety	• Completes safety checks of equipment • Identifies the patient correctly • Checks requirement for test • Checks Expiry dates • Checks and identifies correct test strip • Able to use QC test as necessary • Stores equipment safely during the procedure • Disposes of Sharps safely • When to escalate		
Infection Control	• Decontaminates hands in line with 'Five Moments' • Uses a non- touch technique when performing test • Ensures all equipment is cleaned appropriately • Uses PPI equipment for procedure		
Procedural Competence	Demonstrates knowledge of the equipment including ○ Indications/specific instructions ○ Contraindications/Cautions when not to test • Offers assistances as required to patient and others • Completes the procedure using correct technique according to monitor instructions • Understands skill is not transferable away from normal working area		

Team working	• Documents appropriately
	• Communicates with
	  ○ Nurses
	  ○ Doctors
	  ○ Pharmacists/Technicians where necessary
	• Escalates any concerns including:
	  ○ Patient refusal for test
	  ○ Escalates as policy
	• Cleans and stores away equipment		

Particular Strengths/weakness			Total Score
Specific strategies for Improvement			

Assessors Name……**Assessors Signature**……**Date**……
To be kept by ward manager and updated as policy

Appendix 2: Health Care Assistant Blood Ketone Test Escalation Tool



HCA ESCALATION SUPPORT TABLE

BLOOD KETONE TEST RESULT	ACTION
Above 3.0 mmols/L	**Escalate immediately** - inform registered nurse, NIC observe patient monitor 1 hourly
1.6-3.0 mmols/L	**Escalate** – inform registered nurse and NIC result continue to observe and monitor patient 2 hourly unless requested to do different frequency
0.7-1.5 mmols/L	**Caution** – inform registered nurse and continue to monitor 2 hourly record encourage fluids if appropriate
0.0-0.6 mmols/L	**Normal reading** – continue to monitor as requested, document and inform registered nurse

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