

## Trust Guideline for Capillary Blood Ketone Monitoring For Inpatients with Diabetes Mellitus Over 16 Years of Age

<b>For Use in:</b>	All clinical areas of the Trust
<b>By:</b>	Medical, and Nursing staff who have been specifically trained in blood ketone testing
<b>For:</b>	Inpatient Ward areas using the Roche VTRUST ketone meter
<b>Division responsible for document:</b>	Medical Division (Including Emergency)
<b>Key words:</b>	Blood Ketones. Blood glucose. Blood glucose monitoring, diabetes, ketoacidosis, hyperosmolar hyperglycaemic state
<b>Name and job title of document authors:</b>	Dr Tara Wallace, Consultant Endocrinology Sr Sandra Morris, Sr Esther Walden, Diabetes Inpatient Specialist Nurses
<b>Name and job title of document author's Line Manager:</b>	Professor Mike Sampson, Consultant Endocrinologist.
<b>Supported by:</b>	Professor Jeremy Turner Consultant Endocrinology
<b>Assessed and approved by the:</b>	Clinical Guidelines Assessment Panel If approved by committee or Governance Lead Chair's Action; tick here <input checked="" type="checkbox"/>
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<b>If Yes - does the strategy/policy deviate from the recommendations of NICE? If so why?</b>	N/A

This guideline has been approved by the Trust's Clinical Guidelines Assessment Panel as an aid to the diagnosis and management of relevant patients and clinical circumstances. Not every patient or situation fits neatly into a standard guideline scenario and the guideline must be interpreted and applied in practice in the light of prevailing clinical circumstances, the diagnostic and treatment options available and the professional judgement, knowledge and expertise of relevant clinicians. It is advised that the rationale for any departure from relevant guidance should be documented in the patient's case notes.

The Trust's guidelines are made publicly available as part of the collective endeavour to continuously improve the quality of healthcare through sharing medical experience and knowledge. The Trust accepts no responsibility for any misunderstanding or misapplication of this document.

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## Version and Document Control:

Version Number	Date of Update	Change Description	Author
5	09/03/2021	A mistake was noted it incorrectly read "urine ketones +++/++++", instead of "++/+++".	Dr Tara Wallace Sr Sandra Morris Sr Esther Walden

## This is a Controlled Document

Printed copies of this document may not be up to date. Please check the hospital intranet for the latest version and destroy all previous versions.

## Objective

The aim of this guideline is:

- 1) To outline indications for blood ketone testing and interpretation of results.
- 2) To provide guidance to ensure accuracy when blood ketone testing.
- 3) To demonstrate standards for maintaining quality control.

## Rationale

Diabetic ketoacidosis (DKA) is a major cause of mortality and morbidity in patients with type 1 diabetes. Over the past 20 years there has been no reduction in mortality rates which remain between 3.4 and 4.6% (1).

Insulin deficiency, in combination with increased levels of stress hormones, stimulates lipolysis resulting in the production of acetylCoA (from fatty acids) which acts as the substrate for hepatic synthesis of ketone bodies (acetoacetate, beta-hydroxybutyrate, and acetone).

- In DKA the ratio of beta-hydroxybutyrate ( $\beta$ -OHB) to acetoacetate increases from 1:1 to as much as 5:1 and  $\beta$ -OHB is therefore the predominant ketone body contributing to the acidosis (2).
- Urine dipstick tests (Ketur-test<sup>®</sup>, Combur 9 test<sup>®</sup>) have limited sensitivity and specificity because they do not detect  $\beta$ -OHB – they give only a semiquantitative measure of acetoacetate, react weakly with acetone and there is a time lag between ketones appearing in the blood and being excreted in the urine.
- As the acidosis resolves with treatment,  $\beta$ -OHB is oxidised to acetoacetate. Under these circumstances urine tests may give the misleading impression that ketosis is not improving, and from a practical point of view there can be a problem obtaining urine samples from severely dehydrated patients at the time of presentation.
- Blood  $\beta$ -OHB can be measured with a hand-held sensor – **Roche VTRUST ketone meter** using blood from a fingerprick test. The meter has been shown to be reliable with accuracy and precision that is well within acceptable clinical limits (3-5).

## Trust Guideline for Capillary Blood Ketone Monitoring For Inpatients with Diabetes Mellitus Over 16 Years of Age

- The use of blood ketone tests based on the measurement of  $\beta$ -OHB, rather than urine ketone tests, is now recommended in the Joint British Diabetes Society Inpatient Care Group national guideline for the management of DKA (6).

### When to measure ketones ( $\beta$ -OHB):

Blood ketones should be measured in any patient where there is clinical suspicion of decompensated Type 1 diabetes or in people with Type 2 diabetes who are acidotic at presentation. This includes:

- All patients with suspected new Type 1 diabetes.
- All patients with Type 1 diabetes who are unwell and/or have vomited.
- All patients with urine ketones ++ or +++.
- Any patient with diabetes (Type 1 or Type 2) and acidosis i.e. pH <7.3 and/or bicarbonate <15mmol/L.
- In non diabetic patients if ketosis suspected (**Cons/Endo SpR request only**).

### How to measure blood ketones:

The **VTRUST Ketone meter** should be used to measure blood ketone levels. The meter should be registered with the Point of Care Testing (POCT) Department and monthly external quality control tests must be performed according to Trust guidelines ([Trustdocs Id 8679](#)). Measurements should only be undertaken by appropriately trained staff as follows:

### **Quick Reference Guide for Patient Testing**

1. Put on non-sterile gloves.
2. Either ask the patient to wash their hands with soap and water then dry thoroughly, or swab the patient's finger with water and dry thoroughly. Do NOT use Mediwipes or alcohol to clean the finger.
3. Check that the **VTRUST TD4258  $\beta$ -Ketone strips** are within the printed expiry date, strips should be used within 30 days once opened; handwrite the date on the pot when first opened.
4. Turn on meter. The meter display will ask for Operator ID, press S to scan your operator barcode.
5. Check that 2 quality control tests, using both the  **$\beta$ -Ketone Control Solution levels 1 and 2** have been performed in the last 24 hours. If the QC is required you will not be able to proceed to running a patient sample and the meter will be locked out of patient testing.
6. Carry out QC as/if necessary by selecting QC mode
7. Select Measure Mode to run a patient test.
8. Once option has been selected you will be asked for "Operator ID", press 'S' to scan operator bar code.
9. Then scan "Strip Lot" (bar code found on each pot of strips).

## Trust Guideline for Capillary Blood Ketone Monitoring For Inpatients with Diabetes Mellitus Over 16 Years of Age

10. Then scan “Patient ID” from patient wrist-band band, or medical notes if no wrist band available. **If no patient ID is available enter the date and time as a 10 digit number using the keypad. e.g. 15<sup>th</sup> December 2014 at 10:15am would be entered as 1512141015.**

11. Press the **S** button to continue

12. It will then ask to “Insert the Strip”. Open test strips pot and insert strip into meter.

13. Once strip is inserted properly the meter will read “Apply sample to strip”.

**Note:** Do not lift the meter to view the display until after the test strip has been removed. Doing so may cause control solution/Patient sample to drip onto the port protector or into the strip port, damaging the meter.

14. Place the sample on the end of the test strip. The strip will fill by capillary action. Allow the entire test area to fill with sample.

15. Once sample has been accepted the meter will read “Analysing Sample” and will commence a count-down and will beep once, then display the result.

16. If you wish to run another patient select option 1, and return to step 9. If finished press On/Off button and place back in the docking station.

**Training will be provided by Roche representatives or the Point of Care Testing Team and cascaded via Diabetes Link Nurses.**

### Interpretation of blood ketones (B-OHB)

<b>Below 0.6 mmol/L</b>	<b>These are normal readings:</b> <ul style="list-style-type: none"> <li>• Continue usual diabetes care</li> </ul>
<b>0.6 – 1.5 mmol/L</b>	<b>These are elevated readings:</b> <ul style="list-style-type: none"> <li>• Give 100ml/hr of sugar free fluids orally (unless contraindicated)</li> <li>• Rest</li> <li>• Test blood glucose and ketones 2 hourly until normal</li> </ul>
<b>1.6 – 2.9 mmol/L</b>	<b>At risk of DKA:</b> <ul style="list-style-type: none"> <li>• Contact usual Doctor</li> <li>• Consider contacting DISN (0407) or Endocrine SpR (x 2763)</li> <li>• Consider additional short acting insulin</li> <li>• Give 100ml/hr of sugar free fluids orally (unless contraindicated)</li> <li>• Test blood glucose and ketones in 1 hour</li> </ul>
<b>3.0 mmol/L or over</b>	<b>Likely DKA:</b> <ul style="list-style-type: none"> <li>• Contact Endocrine SpR (x 2763) immediately. Out of hours contact Medical Reg (0022)</li> <li>• Assess patient for signs of DKA, urgently check serum Na, K, bicarbonate and venous pH on blood gas analysis</li> <li>• Access DKA guideline on Trust Intranet (Trust info : Guidelines : Clinical Guidelines : Diabetes)</li> <li>• Test blood glucose and ketones hourly.</li> </ul>

# Trust Guideline for Capillary Blood Ketone Monitoring For Inpatients with Diabetes Mellitus Over 16 Years of Age

## Monitoring blood ketones in Diabetic Ketoacidosis is according to the Trust Guideline

- Blood ketones should be monitored hourly.
- Blood ketones can rise by 1-2 mmol/L per hour.
- With adequate treatment of DKA the blood ketone levels should fall by 0.5 mmol/L per hour.

## Management of Diabetic Ketoacidosis/Ketosis

When ketosis has resolved (<0.6 mmol/L)

- If unable to eat or drink: switch to a variable rate intravenous insulin infusion.
- If well, able to eat and drink and biochemically stable (capillary ketones less than 0.6 mmol/L, pH over 7.3): convert to a subcutaneous regime at a mealtime (not evening meal). Continue intravenous insulin infusion until 30 minutes after subcutaneous short acting insulin has been given with meal (see Withdrawal of Variable Rate Intravenous Insulin Infusions [Trustdocs Id 1357](#)).

Conversion from intravenous insulin to subcutaneous insulin should be managed by the Specialist Diabetes Team.

If ketosis is not resolving, identify and treat the reasons for failure to respond. This situation is unusual and requires senior and specialist input

**These are broad recommendations and if you are concerned about a patient's clinical condition or blood ketone levels the patient should be referred for early review to the diabetes team.**

## Contact details

- During working hours please inform the Diabetes Inpatient Specialist Nurses (bleep \*\*\*\*) Monday to Friday 09.00 to 17.00.
- Out of hours until 21.00 and weekends Endocrine doctors (Bleep \*\*\*\*).
- For emergency advice overnight - Consultant on call via switchboard.

## Clinical audit standards

All patients who are suspected of having DKA should have a blood ketone measurement taken.

All patients with a blood ketone measurement above 3.0mmol will be treated according to the national DKA guidelines.

Weekly ketone quality control checks will be performed.

Audit can be undertaken with a retrospective review of case notes and observation charts.

# Trust Guideline for Capillary Blood Ketone Monitoring For Inpatients with Diabetes Mellitus Over 16 Years of Age

## **Broad Recommendations**

Blood ketones must be measured in unwell patients with diabetes who are suspected to have acidosis using the **Roche VTrust Blood Ketone meter**.

In patients with Diabetic Ketoacidosis or ketosis, blood ketone measurements should be used to guide treatment and monitor response to treatment.

Areas in NNUH using the VTrust meters at the time of writing are **A&E, AMU, ANC, Aylsham MDU, Brundall, Buxton, CAU, CCC, ChED, CIU, Cley, Coltishall, Cringleford, Denton, Docking, DPU Recovery, Dunston, Earsham, Easton, EBDC, Edgefield, Elsing, Gateley, GissingHDU, Guist, Gunthorpe, Hethel, Heydon, JLOP, JPU, Kilverstone, Kimberley, Langley, Loddon, Mattishall and Mulbarton wards.**

## **Summary of development and consultation process undertaken before registration and dissemination**

This document was developed after discussions between the Pathology services and Diabetes department, Assistant Director of Nursing for Medicine and the Practice Development and Education Department. This version has been endorsed by the Clinical Guidelines Assessment Panel.

## **Distribution list/ dissemination method**

Elsie Bertram Diabetes Centre  
Trust Intranet

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## **Further Reading:**

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## Trust Guideline for Capillary Blood Ketone Monitoring For Inpatients with Diabetes Mellitus Over 16 Years of Age

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# Trust Guideline for Capillary Blood Ketone Monitoring For Inpatients with Diabetes Mellitus Over 16 Years of Age

## Appendix 1

### Sick Day Rules

Adults with Diabetes Undergoing Surgery and Elective procedures ([Trustdocs Id: 1276](#)) (page 34).

#### What should I do if I am unwell?

- **NEVER** stop taking your insulin or tablets – illness usually increases your body's need for insulin
- **TEST** your blood glucose level every 2 hours, day and night
- **TEST** your urine for ketones every time you go to the toilet or your blood ketones every 2 hours if have the equipment to do this
- **DRINK** at least 100 mls water/sugar free fluid every hour – you must drink at least 2.5 litres per day during illness (approximately 5 pints)
- **REST** and avoid strenuous exercise as this may increase your blood glucose level during illness
- **EAT** as normally as you can. If you cannot eat or if you have a smaller appetite than normal, replace solid food during illness, with one of the following:
  - 400 mLs milk.
  - 200 mLs carton fruit juice.
  - 150-200 mLs non-diet fizzy drink.
  - 1 scoop ice cream.