Anomalous point-of-care ketone reading following use of ethyl chloride spray as a topical anaesthetic during the treatment of a teenager with DKA

Abstract
We present the case of an anomalous ketone reading in a 16-year-old female patient with type 1 diabetes following the administration of ethyl chloride spray as a topical anaesthetic. The patient presented in diabetic ketoacidosis (DKA) and was agitated, distressed and combative. Assistance was sought in the ongoing management of the patient from the on-call anaesthetic and intensive care team. The choice was made to use ethyl chloride spray as a topical anaesthetic. This was done in order to decrease the discomfort of capillary blood tests in an attempt to ameliorate the patient's agitation and distress. It was noted that when this spray was applied prior to point-of-care ketone concentration testing, a ketone reading out of context of the clinical picture was obtained.

There is no caution against using ethyl chloride spray in the product literature for the ketone meter used in our hospital, but there is guidance about cleaning the hands and test site with soap and warm water. This was briefly investigated by this team and anomalous ketone concentrations were reproduced in a healthy volunteer who had ketone levels checked pre- and post-application of ethyl chloride spray. There is no current published literature regarding abnormal ketone results following application of topical anaesthetic agents. Therefore, based on this experience, caution would be advised in using topical anaesthetic agents prior to capillary blood sampling and emphasis placed on strict adherence to the manufacturer’s guidance of cleansing the hands and test site with warm water and soap prior to capillary sampling. Copyright © 2018 John Wiley & Sons.

Key words
anaesthetic; ethyl chloride; diabetic ketoacidosis; ketones; point of care

Introduction
Diabetic ketoacidosis (DKA) is a common metabolic emergency and a relatively common presentation to secondary care. Intensive care involvement is often sought when patients are in severe DKA or when difficulty in stabilising the patient is encountered. Point-of-care ketone meters that make use of a capillary blood sample taken via finger prick are becoming increasingly commonplace. This method of ketone measurement has superseded the use of urine dip stick testing in the diagnosis and management of DKA.

We present the case of a 16-year-old female who had an anomalous point-of-care ketone reading using the Abbott FreeStyle ketone meter that is used as our hospital’s point-of-care ketone meter. The anomalous ketone concentration occurred when ethyl chloride spray was applied as topical anaesthesia to the chosen finger prior to the finger prick to draw capillary blood.

Case history
The paediatric department requested anaesthetic assistance in obtaining venous access in a 16-year-old female, known to have type 1 diabetes, who had presented in DKA. The ward staff were experiencing difficulties in cannulating her as she was peripherally shutdown. The patient was thought to have an intercurrent illness and typically managed her type 1 diabetes well, with regular blood sugar level monitoring via finger prick.

As part of her DKA treatment the patient was having capillary blood ketone concentration monitored with a point-of-care ketone meter. The capillary blood was being obtained via finger prick with a standard lancet. Prior to our involvement, the meter showed the patient’s ketone concentration to be 4mmol/L.

The patient was confused, distressed and agitated and therefore was transferred to theatre recovery. This was primarily to be in a clinical area with ultrasound to facilitate the
placement of large-bore venous access, but secondarily to be in a clinical area for stabilisation with appropriate staff and facilities to undertake central access, invasive arterial blood pressure monitoring and intubation and ventilation if required in the event of acute deterioration or failure of stabilisation.

As part of the ongoing management, a subsequent ketone reading was required. The patient, now in theatre recovery, had the test carried out with the same lancets and device used on the ward (the paediatric nursing team had brought up the latter in a carry case when transferring the patient). Treatment was ongoing, but Axongesic ethyl chloride spray, which is readily available in the theatre suite, was first applied to the finger chosen for the blood to be taken from. This was done in an attempt to provide some analgesia to the site as the patient seemed to become increasingly distressed and agitated by the finger pricks that had been undertaken on the ward. The blood was then drawn from the area where the topical anaesthetic had been applied. The ketone concentration provided by the point-of-care meter was 14mmol/L. The test was immediately repeated on the patient on a different finger, without the ethyl chloride spray, and the ketone concentration was 4mmol/L, in keeping with the previous readings.

Discussion

The main ketone body in DKA is β-hydroxybutyrate. Point-of-care testing for blood concentration of β-hydroxybutyrate has been shown to be superior to urinary testing of acetone and is a recommended measurement method of ketone testing in patients with diabetes.2-4

The point-of-care ketone meter used at our hospital is the Abbot Freestyle Optium Neo machine. This machine is used for testing both blood glucose and ketones; it measures blood β-hydroxybutyrate concentration in mmol/L.

Ethyl chloride spray is a cryo-anaesthetic agent that fulfills many properties of an ideal topical anaesthetic: its onset is immediate, it is non-invasive, it is effective, its offset is rapid and, in addition to these, it is low cost. Ethyl chloride spray is readily available in most hospital anaesthesia departments and has been demonstrated to be valuable as a topical anaesthetic in a range of paediatric and adult environments.5–9 Therefore it seemed appropriate to apply it in an attempt to minimise the discomfort from finger prick blood testing.

To further investigate the potentially anomalous reading we conducted a simple experiment with the same hospital-issue, point-of-care ketone meter. We measured the ketone concentration of a healthy volunteer. The level was 0.1mmol/L. We then repeated the measurement having used ethyl chloride spray to first anaesthetise the skin and a reading of 1.1mmol/L was returned.

There is no entry in the product literature of our hospital’s meter cautioning against the use of ethyl chloride spray prior to finger prick ketone testing.10 We therefore undertook a literature search; there are reports in the literature of drugs containing free sulphhydryl groups such as captopril, N-acetylcysteine and penicillamine giving false positives in urinary ketone testing.11 With regard to point-of-care blood ketone testing, there is a recent report of hydroquinone containing skin lightening cream giving false positive ketone results with devices like ours that detect β-hydroxybutyrate concentration.12 There are no case reports of ethyl chloride spray giving anomalous ketone results.

The product literature, however, does clearly state in section 7: ‘Wash your hands and the test site with soap and warm water; ‘Rinse and dry thoroughly; ‘Do not use lotion or cream on the test site’.13 It is well documented that even very minor contamination of the skin of a chosen test site can significantly affect blood glucose testing.13,14 This is most likely the case for ketone testing also. Therefore this serves as a further, yet equally valuable, caution that the chosen site of a test should be appropriately prepared with soap and warm water to avoid erroneous results by contamination.

Another potentially important consideration in understanding the anomalous ketone result is that the ethyl chloride spray is cold. The product literature advises warm water for cleaning prior to testing.10 The assumption being made in using the point-of-care meter is that the concentration of β-hydroxybutyrate in the capillary blood in the finger is representative of that in the rest of the circulation. Although there will be minor differences in concentration between artery, vein and capillary, these would usually not be clinically significant differences. The vigorous cooling of the test site by ethyl chloride spray will cause constriction of vessels. This will potentially slow or cause temporary cessation of blood flow in the digit and this may result in the concentration of β-hydroxybutyrate in the capillary blood not being comparable with the rest of the circulation, conceivably producing a ketone reading significantly different from the rest of the circulation – thus making the result difficult to interpret and potentially appearing as anomalous.

Abbott Diabetes Care UK were contacted via the contact form on their website. It was explained that an erroneous result had been obtained when using ethyl chloride spray as a topical anaesthetic. They were not aware of other reports of ethyl chloride spray causing erroneous results. They went on to advise that ‘prior to ketone test using our test strips, we do not recommend to use any gels, sprays or creams as it might cause results to not reflect actual blood level,’ and reiterated: ‘The only test preparation as per our User Guide is “Wash your hands and the test site with warm soapy water to ensure accurate results. Thoroughly dry your hands and the test site.”’

In order to raise awareness locally, this case was presented as a poster at the North of England Intensive Care Society Spring Meeting in March 2018. In addition to this, the case has been taken to the trust diabetes care teams, both adult and paediatric.

In summary, we would caution against the use of ethyl chloride spray as a topical anaesthetic prior to obtaining capillary blood via finger prick for point-of-care blood ketone level testing as, with its use, we have encountered anomalous...
ketone concentration readings. We would also take this opportunity, firstly, to further remind users of a point-of-care ketone meter to familiarize themselves with the user manual guidance. Secondly, those users of the same machine as ours should cleanse the hands and test site with soap and warm water and thoroughly dry them, prior to testing.

**Key points**
- We caution against the use of ethyl chloride spray as a topical anaesthetic prior to point-of-care capillary blood ketone concentration monitoring.
- We reiterate the importance of proper cleansing of the hands and test site prior to point-of-care testing.

**Declaration of interests**
There are no conflicts of interest declared.

**References**
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