

# Overestimation by a Hand-Held Glucometer of Blood Glucose Level due to Icodextrin

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It is often difficult to determine the cause of changes in mental status in critically ill patients. Clinicians often rely on data collected by various means – such as medical history, physical examination, imaging, laboratory tests – to help diagnose the condition. However, laboratory data can be misleading. Caregivers should be aware of conditions that might falsely change the results. In the following case we describe such a discrepancy in a hand-held glucometer, a widely used device that is usually accurate.

## PATIENT DESCRIPTION

A 30 year old man with a history of coronary artery disease, diabetes mellitus, and end-stage renal disease treated with peritoneal dialysis presented after 2 days of hematemesis. He reported compliance with all medications, including clonidine, clopidogrel, ezetimibe, diphenhydramine, metoprolol, atorvastatin, citalopram, insulin glargine, metoclopramide, lisinopril, and omeprazole. He had also been compliant with peritoneal dialysis. He was admitted to the intensive care unit and treated with intravenous pantoprazole, intravenous hydration, and monitoring of his gastrointestinal bleeding. Following admission, repeat laboratory data showed the development of anion gap metabolic acidosis, with hyperglycemia and positive serum

acetone. Diabetic ketoacidosis was diagnosed and an insulin drip initiated.

On the second hospital day there was an abrupt deterioration in his mental status. He was unresponsive to verbal stimuli and poorly responsive to physical stimuli. His pupils reacted normally to light, and there were no focal neurologic deficits. His blood pressure, heart rate, respiratory rate, and temperature were normal. His O<sub>2</sub> saturation was 97% while receiving oxygen via nasal prongs at 2 L/min. Cardiac, pulmonary and abdominal examinations were normal. Bedside finger stick glucose testing measured 188 mg/dl on two separate occasions.

Because of a strong concern regarding hypoglycemia, 25 ml of 50% dextrose was administered intravenously after blood had been drawn for a serum basic metabolic panel. The patient's mental status quickly returned to normal. The BMP, sent before administration of dextrose, revealed a serum glucose level of 18 mg/dl.

## COMMENT

Hypoglycemia, frequently encountered in intensive care units and emergency departments, is a life-threatening yet easily treatable condition. Using hand-held glucometers generally facilitates the diagnosis of this condition, thus enabling a quick response by administering glucose. Some conditions, however, have the potential to interfere with glucose measurements by hand-held glucometers and provide incorrect values for serum glucose.

In patients with end-stage renal disease, peritoneal dialysis is used as an alternative to hemodialysis. In PD a glucose-based dialysate is used for ultrafiltration. Over time, however, structural changes in the mesothelium may lead to a reduced effect of PD [1]. Icodextrin, a cornstarch-derived glucose polymer, may be used as an alternative to glucose-based dialysates to improve ultrafiltration [2]. When used in PD fluid, 20–30% of icodextrin is absorbed into the systemic circulation and is metabolized to oligosaccharides such as maltose, maltotriose and maltotetrose [3]. Icodextrin may also be found in some chemotherapy solutions.

Icodextrin metabolites, especially maltose, may be detected with some glucometer enzymatic reactions and falsely measured as glucose [2-5]. Most glucometers use one of two enzymes – glucose oxidase or glucose dehydrogenase – to detect the presence of glucose. In these reactions, glucose is metabolized by GOD or by GDH to hydrogen peroxide or reduced nicotinamide adenine dinucleotide, respectively. The amount of hydrogen peroxide or rNAD can then be measured by oxidized dye color change or by electrochemical reactions to calculate the amount of glucose present [1]. Reducing agents other than glucose, such as metabolites of icodextrin, may also be detected by these methods. Since neuronal cells use glucose as the primary source of adenosine triphosphate

PD = peritoneal dialysis  
GOD = glucose oxidase  
GDH = glucose dehydrogenase  
rNAD = reduced nicotinamide adenine dinucleotide

BMP = basic metabolic panel

production and poorly utilize maltose as an energy source, the false detection of maltose or maltotriose as glucose can obviously have dire consequences if serum glucose levels are in fact very low.

While it is generally thought that the GDH method is more susceptible to false detection of glucose by icodextrin metabolites [2,3], both methods are susceptible to interference [4]. One study showed that in 25 patients treated with icodextrin-containing dialysate fluid [5], using a GOD-based glucometer, glucose level measurements were elevated by more than 20% in all but one measurement, when compared with those measured by a laboratory-based system.

Other conditions also have the potential to interfere with glucose measurements by hand-held glucometers. High or low hematocrit values can lead to falsely abnormal glucose readings. Also, high levels of uric acid, which is a reducing agent, may result in falsely high glucose readings [1]. Both of these conditions are common in critically ill patients and in patients with renal failure. The table describes how the presence of icodextrin and its metabolites, high uric acid levels and changes in hematocrit interfere with the measurement results of different types of glucometers. The information was compiled from data published in the literature [4] and warn-

**Table.** Interference in results of glucose measurements with icodextrin, uric acid and high or low hematocrit

Device name and manufacturer	Icodextrin	Uric acid	Hematocrit
Glucotrend®, Roche Diagnostics	Yes	No	No
Advantage®, Roche Diagnostics	Yes	Yes	Yes
Accu-Check®, Roche Diagnostics	Yes	No	Yes
MediSenseG2®, MediSense	No	No	Yes
One Touch®, Lifescan	No	No	Yes
FreeStyle Systems®, CoZmonitor® and Optium Omega®, Abbott	Yes	No	Yes
Ascensia® (except for Ascensia Contour GDH-PQQ), Bayer	No	N/A	N/A

Data from the literature [4] were provided by manufacturers of the devices and the manufacturer of icodextrin (Baxter). For certain devices the some information was not available (N/A).

ings published by the manufacturers of the devices and the manufacturer of a peritoneal dialysate containing icodextrin (Extraneal® by Baxter).

In our patient, the low glucose measured by the serum basic metabolic profile clearly indicated true hypoglycemia, and administration of intravenous glucose abruptly reversed his mental status change. The glucose level of 188 mg/dl on the hand-held glucometer indicates substantial interference of the glucose measurement by metabolites of icodextrin. As strict glycemic control becomes ever more common in critical care settings, accurate glucose measurements are essential.

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