Special Report

False Positive Finger Stick Blood Glucose Readings After High-Dose Intravenous Vitamin C

It has been discovered that high-dose intravenous ascorbic acid (AA), at 15 grams or higher, will cause a "false positive"on various finger stick blood glucose strips read on a "meter." This is of major importance in a cancer patient receiving this treatment if the patient also has diabetes.

For some reason the strips appear to be "reading" ascorbic acid (or perhaps the dehydro-ascorbic acid) as glucose. The two molecules are very similar. The molecular weight of glucose is 180.16 while that of ascorbic acid is 176.12.

This false positive does not occur when the test is performed on serum glucose using the hexokinase glucose reference method, the procedure used in our laboratory. The BioCenter Laboratory and Center Physicians tested serum glucose levels in six patients receiving various levels of I.V. ascorbic acid. The serum glucose was not affected by the high dose AA. The results are shown below:

Amount of AA	Pre I.V. AA glucose	Post I.V. AA glucose
15 g	92 mg/dL	85 mg/dL
15 g	89 mg/dL	85 mg/dL
25 g	130 mg/dL	103 mg/dL
50 g	81 mg/dL	85 mg/dL
50 g	88 mg/dL	92 mg/dL
50 g	101 mg/dL	86 mg/dL

In another study, one of the authors (JAJ) received 25 grams of intravenous AA in water (Mega-C-Acid Plus, Ascorbic Acid Injection®, 500 mg/mL, Merit Pharmaceuticals, Los Angeles, Ca 90055). One drop of this solution placed on the glucose strip read on the Abbott meter gave an error code "Too high to read," or over 500 mg/dL.

Before the infusion, a pre finger stick glucose, a serum glucose and a plasma AA were performed. Thirty minutes into the infusion (Mid), and immediately after the infusion (Post), another finger stick glucose, serum glucose and plasma AA were performed. The results are shown in Table 1 (p.189).

After the post blood measurements, finger stick glucose values were performed at 30 minute intervals up to 3.5 hours in order to determine how long the AA would affect the blood glucose strips. One hour after the post I.V. AA (363 mg/dL), the finger stick glucose was 269 mg/dL; after two hours it was 181 mg/dL; 3.5 hours later it was 138 mg/dL. The readings were discontinued since the patient had not eaten lunch or dinner. It would appear that in this case, it took two hours for the glucose measurement on the finger stick to fall to half the pre-IV level (181 mg/dL from 363 mg/dL). Of course, higher blood levels of AA may prolong this time, based on the serum half-life of AA.

The plasma AA concentrations are interesting. The product insert for the blood glucose strip states that vitamin C levels of up to 2.3 mg/dL will not interfere with the glucose reading. The pre level was 3.2 mg/dL and DID not interfere with the strip, (110 mg/dL on both the strip and serum glucose).

However, values of 69.2 mg/dL of plasma AA increased the finger stick glucose to 251 mg/dL and 101 mg/dL increased the finger stick to 363 mg/dL! None of the serum glucose results were affected.

In two other cases reported to Dr. Jackson (using the same Abbott system), both finger stick glucose readings were 495 mg/dL. In one elderly patient with metastatic colon cancer and diabetes, a finger stick glucose was performed after a high dose I.V. AA treatment. Her finger stick glucose read 495 mg/dL! She was given 30 units of insulin and later went into hypoglycemic shock! Her husband was a physician and fortunately she

Table 1. Finger stick glucose[a], serum glucose[b] and plasma AA[c], pre, mid and post 25 grams I.V. AA.

	Pre I.V. AA	Mid I.V. AA	Post I.V. AA
Finger stick glucose	110 mg/dL	251 mg/dL	363 mg/dL
Serum glucose	110 mg/dL	103 mg/dL	96 mg/dL
Plasma ascorbic acid	3.2 mg/dL	69.2 mg/dL	101 mg/dL

a. Precision Xtra Instrument® XCA170-2151 and MediSense® Precision Xtra blood glucose strips, lot #40872, Abbott Laboratories, Abbott Diabetes Care, Alameda, CA 94502: Glucose control solution MID®, lot #57802, range 67 to 123 mg/dL. Controls run before and after were 97 mg/dL and 101 mg/dL.
b. Enzymatic method run on the COBAS MIRA Plus® using a reagent kit, Glucose-SL Assay®) from Diagnostic Chemicals Limited, Oxford, CT 06478. The method is a totally enzymatic method using hexokinase and glucose-6-phosphate dehydrog-enase.
c. High Performance Liquid Chromatography method performed on 3.0 mL of plasma mixed with cold 4.5 mL of 3% metaphosphoric acid, mixed by vortex, centrifuged and the sample run immediately or frozen. See www.biocenterlab.org for more information on this test.

recovered. When contacted by us, the daughter was instructed to obtain a finger stick blood glucose and serum glucose before the next I.V. injection. Because of anemia, only a finger stick glucose was performed: it read 131 mg/dL. After the I.V. AA treatment, the finger stick glucose was 495 mg/dL while the serum glucose was 151 mg/dL!

In the second case, a patient with diabetes received a high dose I.V. AA treatment. While walking away, she fainted. The finger stick glucose was 495 mg/dL. They phoned us and we suggested they do a serum glucose from the local laboratory. It was normal. They also had one of their employees volunteer to give a pre I.V. serum glucose sample and receive a 15 gram I.V. AA infusion. At the end of the I.V. infusion, another serum glucose was performed. Both the pre and post I.V. AA serum glucose tests were normal.

We checked 13 more patients (non-diabetic) receiving I.V. AA at 15 to 100 gram doses, some post I.V., some during the I.V. In all cases the strips and meters gave very elevated reading, five greater than 500 mg/dL. The Abbott meter and strip also gave a warning reading of "high ketones."

One of our physicians asked if the finger stick glucose correlated with the plasma AA levels. When looking at the few data points from our experiment, an interesting correlation was found. Since this is only one set of results (n=1), it may only be a coincidence. The finger stick glucose levels in the mid and post samples appeared to be about 3.5 times higher than the plasma AA levels. When the finger stick glucose levels were divided by 3.6 one could get a close approximation of the plasma AA levels at *low levels*. The mid finger stick glucose level was: 251 mg/dL: 251 mg/dL ÷ 3.6 = 69.7 mg/dL AA (the actual value was 69.2 mg/dL).

The post I.V. finger stick glucose was 363 mg/dL:

363 mg/dL ÷ 3.6 = 100.8 mg/dL AA (the actual was 101 mg/dL).

However, this information has little clinical use since the highest blood glucose level that can be obtained with the Abbott finger stick glucose and meter is 500 mg/dL. Therefore, one could only convert to a plasma AA equivalent of 138.9 mg/dL (500 ÷ 3.6 = 138.9 mg/dL). One would have to have an abnormal reading (with dilutions) of 1400 mg/dL to get about a 388 mg/dL equivalent. The linearity would not allow this conversion to be accurate.

These finding with two of the Abbott Company's instruments were called into two different "customer service personnel" at Abbott Laboratories cautioning them of these findings. We offered to share our findings with them. Later a representative said that the "scientific" department had checked this and found that it was true and would make a correction to the product insert.

We have had five reports of false positive finger stick glucose readings after high-dose I.V. AA. We know of two other who also found this interference. Unfortunately, we do not have the name of the other meters or finger stick products, but since the test principle is probably the same in all strips, the interference will also occur. We do know that the Bayer Glucometer Elite XL™ with the Ascensia Elite™ strips and the Kroger™ meter and strips all give a false positive glucose reading after high dose I.V. AA. The Abbott product insert states that the strip readings from patients and other experiments were compared to the Yellow Springs Analyzer® (YSI), not the reference hexokinase chemical method. The YSI analyzer and newer glucose strips make use of a small electrical current generated when blood glucose comes in contact with the reagents in the strip. The reagents listed On the Abbott strip are Glucose Dehydrogenase (Microbial) >0.03 U, NAD+ (as sodium salt) >1.0 µg, Phenanthroline quinone >0.02 µg, Non-reactive ingredients >16.3 µg. The older colormetic glucose strips did not show this false positive reaction.

The authors hope that all health care workers will be aware of this potential for false positives on the finger stick glucose method following high dose I.V. AA and caution the diabetic patient to wait about eight hours before performing the test. If a glucose test is needed before that time, a serum glucose may be obtained from a certified laboratory using the hexokinase method, not the YSI analyzer. It does not appear that oral intake of vitamin C in any form will affect the finger stick glucose procedure. One of the authors is a Type II diabetic and takes a minimum of six grams of oral vitamin C a day. It has not caused a rise in his serum or finger stick glucose.

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