Clin Chem Lab Med 2006;44(11):1376–1378 © 2006 by Walter de Gruyter • Berlin • New York. DOI 10.1515/CCLM.2006.249

Analytical validation of the new plasma calibrated Accu-Chek® Test Strips (Roche Diagnostics)

Cécile Meex*, José Poncin, Jean-Paul Chapelle and Etienne Cavalier

Department of Clinical Chemistry, CHU Liège, University Liège, Sart-Tilman, Belgium

Abstract

Background: The Accu-Chek Inform glucose monitor is a point-of-care system for testing blood glucose. New test strips, calibrated to deliver glucose plasma-like values, were launched on the market in May 2005. The aim of our study was to perform analytical validation of these new strips.

Methods: We compared the new plasma strips with whole blood strips; results for the plasma strips with plasma values obtained using a clinical analyzer and with whole blood values given by the glucose electrode of a blood gas analyzer; and the influence of the type of blood (capillary or venous) on the results obtained by the glucose monitor with the plasma calibrated strips.

Results: Plasma strips give on average 7% higher results than the previous whole blood strips. However, the results given by the plasma strips on capillary whole blood, even if well correlated, are not completely comparable with those given by an analyzer for venous plasma. Nevertheless, these plasma strips and the glucose electrode of a blood gas analyzer give comparable results.

Conclusions: Accu-Chek Inform plasma strips are a good method for monitoring of blood glucose values in patients with diabetes.

Clin Chem Lab Med 2006;44:1376–8.

Keywords: Accu-Chek Inform; blood gas analyzer; capillary blood; glucose; plasma strips; reference method.

Introduction

The Accu-Chek Inform glucose monitor is a point-of-care system for testing blood glucose (glucose dehydrogenase method, amperometric detection) that can be used by professionals in healthcare facilities.

Since December 2004 our hospital has used Accu-Chek Inform monitors, which are distributed in all wards of the hospital. The glucose results are sent via our network to the software DataCarePOC (Roche) and on to our laboratory information system (LIS).

*Corresponding author: Cécile Meex, Chemist, Department of Clinical Chemistry, CHU Liège, 4000 Sart-Tilman, Belgium
Phone: +32-43-667665, Fax: +32-43-667392,
E-mail: c.meex@chu.ulg.ac.be

Harmonization of the reporting of glucose concentrations is essential. Indeed, clinical staff generally do not know whether the laboratory reports blood or plasma glucose. The International Federation of Clinical Chemistry and Laboratory Medicine (IFCC) advises expression of the concentration of glucose in plasma rather than in whole blood, regardless of the sample type and technology. Moreover, the American Diabetes Association provides clinical decision limits for the concentration of glucose in plasma.

The IFCC recommends a constant factor of 1.11 to convert measured glucose concentrations in whole blood to the equivalent concentrations in plasma (1). However, this converted result equals the concentration of glucose in plasma only when hematocrit and water concentrations are normal.

Considering these observations, in May 2005 Roche launched new test strips calibrated to deliver glucose plasma-like values. They established a conversion factor of 1.08, supposed to be more applicable to any patient.

We decided to validate the plasma strips before their use in the wards. In complement of repeatability and reproducibility, we compared: the new plasma strips with the whole blood strips; the results of the plasma strips with the plasma values obtained using a clinical analyzer and with the whole blood values given by the glucose electrode of a blood gas analyzer; and the influence of the type of blood (capillary or venous) on the results obtained by the glucose monitor with the plasma calibrated strips.

Materials and methods

We decided to use the same Accu-Chek Inform monitor for all validation testing to avoid potential variations between instruments.

The first step of our validation was to compare results given by the plasma strips with those given by the former whole blood strips. For this purpose, we collected 60 samples of venous whole blood in EDTA tubes: 20 fresh samples were used to obtain normal glucose levels (3.3–5.5 mmol/L), 20 one-day-old samples to obtain low glucose levels (<3.3 mmol/L) and 20 samples from diabetic patients for high glucose levels (>11 mmol/L). A drop of blood from each sample was first applied to the plasma strip and then to the whole blood strip.

In addition, we took blood samples from ten premature babies and analyzed them using the plasma and whole blood strips to investigate whether a high hematocrit level influences the glycemia results.

To ensure that the results given by the plasma strips coincided with real plasma glycemia, we compared them with those given by an analyzer (Integra® 700; Roche, Mannheim, Germany, hexokinase method) for plasma. From 54 hospitalized patients we simultaneously collected a drop of cap-

Table 1 Correlation and significant differences between results given by the plasma (PL) and whole blood (WB) strips in each group of samples.

	Normal glucose (3.3–5.5 mmol/L) (n=20)	High glucose (>11 mmol/L) (n=20)	Low glucose (<3.3 mmol/L) (n=20)	High hematocrit (premature babies) (n=10)	All samples (n=70)
Correlation between PL and WB strips	0.9732	0.9876	0.9262	0.9880	0.9965
PL strips					
Mean, mmol/L	4.12	15.03	2.06	4.47	6.67
SD, mmol/L	0.53	5.45	0.85	1.40	6.10
CV, %	12.92	36.26	41.30	31.30	91.56
WB strips					
Mean, mmol/L	3.77	14.07	1.96	4.09	6.21
SD, mmol/L	0.57	4.87	0.84	1.16	5.67
CV, %	15.05	34.62	42.71	28.37	91.30
Difference between PL and WB strips	$p<0.0001$	$p=0.0001$	$p>0.05$	$p<0.01$	$p<0.0001$

illary whole blood by puncture and a fluoride tube of venous whole blood. The capillary whole blood was directly analyzed by the Accu-Chek Inform monitor using plasma calibrated test strips. The fluoride tubes were conserved on ice and centrifuged within 2 h of collection and glucose was measured in plasma using the Integra 700.

We also compared the results of the plasma strips with those given by a blood gas analyzer (Rapidlab® 865, Bayer, Tarrytown, NY, USA; glucose oxidase method, amperometric detection) since the Intensive Care Unit (ICU) uses these two instruments interchangeably.

A total of 20 syringes of whole blood (11 arterial and 9 venous) were drawn in the ICU. The syringe was first used for the determination of glycemia using the glucose electrode of a blood gas analyzer. Glucose was immediately measured in a drop of blood from the same syringe on the Accu-Chek Inform monitor using a plasma calibrated test strip.

Finally, we investigated whether samples of capillary and venous whole blood gave the same glucose results using the Accu-Chek Inform plasma strips. For this purpose, we simultaneously collected a drop of capillary whole blood by puncture and an EDTA tube of venous whole blood from 20 hospitalized patients. The capillary whole blood was directly analyzed by the Accu-Chek Inform with the plasma calibrated test strips, followed by a blood drop from the EDTA tube.

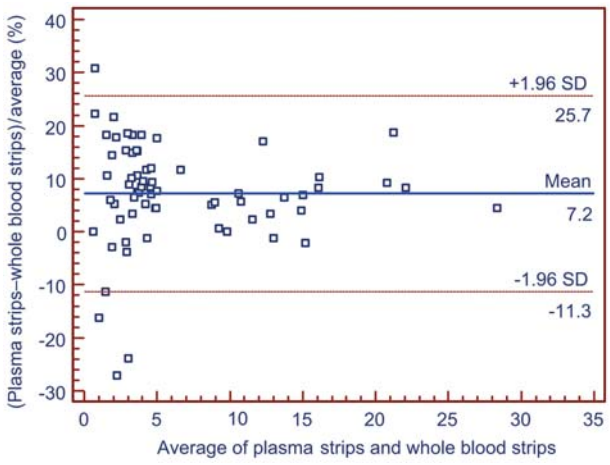

Figure 1 Comparison between the results given by the Accu-Chek Inform plasma calibrated strips and the Accu-Chek Inform whole blood strips.

Statistics

We used Spearman correlation, the Wilcoxon test, the Mann-Whitney U-test and Bland-Altman plots for our statistical calculations using Medcalc software (Mariakerke, Belgium).

Results

The repeatability, performed on low- and high-level controls provided by Roche (laboratory means 3 and 18 mmol/L), gave coefficients of variation of 3.03% and 3.22%, respectively. For reproducibility, coefficients of variation of 5.26% and 2.99%, respectively, were obtained for the same materials.

Comparison between the plasma and whole blood strips was conducted using 70 samples (60 with normal, low and high glucose concentration level and 10 with high hematocrit).

We observed a significant difference between the results obtained with the plasma and the whole blood strips for the 70 samples ($p<0.0001$) except for the low concentration samples (Table 1).

The results of the plasma strips were on average 7% higher than those given by the whole blood strips (Figure 1). The correlation was excellent in every case.

There was a statistically significant difference between the results given by the Accu-Chek Inform and the Integra 700 ($p<0.05$, $n=54$). The results of the Accu-Chek Inform were mainly higher than those given by the Integra 700, ranging from −3% to 24% (Figure 2). The correlation was good ($r=0.9780$).

For the 20 samples drawn in the ICU, there was no significant difference between the results given by the blood gas analyzer and those given by the Accu-Chek Inform, regardless of whether arterial blood or venous blood samples were used ($p>0.05$). We observed good correlation between the methods ($r=0.9778$).

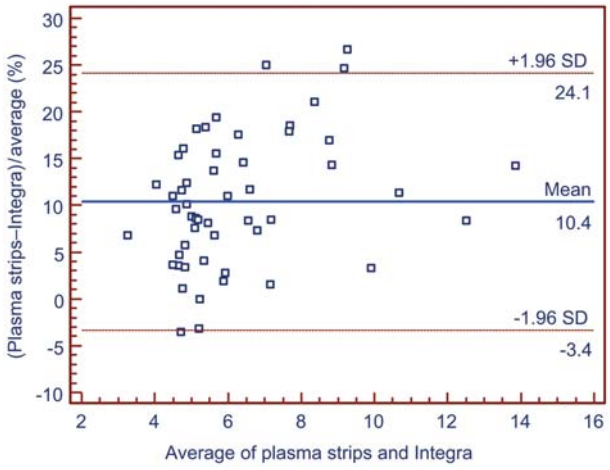

Figure 2 Comparison between the results given by the Accu-Chek Inform plasma strips and the clinical analyzer (Integra 700).

There was no significant difference between glucose measured in capillary whole blood or venous whole blood with the plasma calibrated Accu-Chek test strips ($p > 0.05$). The correlation was good ($r = 0.9615$).

Discussion

It is well known that blood glucose measurements using reagent strip tests vary inversely with increasing sample hematocrit (2, 3). The new Accu-Chek Inform plasma calibrated strips have been designed to give plasma-like glucose values independent of the hematocrit level.

Our first comparisons confirm this observation, since the difference observed between the results given by the plasma strips and those given by the whole blood strips was 7% on average for each group we studied, including samples with high hematocrit. This led us to conclude that neither the hematocrit level nor the glucose concentration influences the difference between the plasma strips and the whole blood strips.

We observed a statistical difference between the results given by the Accu-Chek Inform on capillary whole blood with the plasma strips and those given by the Integra 700 on venous plasma. We first thought that this difference depended on the puncture site. Indeed, studies (4) have reported that as well as matrix effects (normally corrected by the plasma calibrated test strips), physiological mechanisms such as non-fasting conditions can lead to different glucose levels in capillary and venous blood. However, we showed that there was no statistical difference between glucose measured in capillary whole blood and venous whole blood with the Accu-Chek Inform plasma strips.

The second possibility to explain the higher glucose results given by the Accu-Chek Inform compared to the Integra results for venous plasma was the delay before centrifugation (5). Indeed, NaF, even if fluoride tubes are conserved on ice, has no effect during the first hour, but begins to slow down glycolysis by the second hour, inhibiting it more or less completely by the fourth hour. This could explain the lower results observed with the Integra analyzer. The decrease in glucose concentration in fluoride tubes is unfortunately very variable from one patient to another, explaining why the correction factor applied to the plasma strips did not lead to results comparable to those given by an analyzer for plasma sample.

There was no statistical difference between results given by the plasma strips and those given by a blood gas analyzer. The puncture site here was the same, which is not the case in reality. Our study also showed that the Accu-Chek Inform plasma strips gave comparable results for capillary and venous whole blood. We can thus conclude that the Accu-Chek Inform glucose monitor with plasma strips gives comparable glucose results to the glucose electrode of a blood gas analyzer. This is an important finding, particularly for the ICU, where physicians interchangeably use the glucose monitor or a blood gas analyzer for glucose monitoring of patients.

There was good correlation between the Accu-Chek Inform results for capillary whole blood and the clinical analyzer results for plasma. The Accu-Chek Inform plasma strips represent a good system for the monitoring of diabetic patients, particularly in the ICU, where physicians can use either the Accu-Chek Inform monitor or a blood gas analyzer.

References

1. IFCC recommendation on reporting results for blood glucose. Clin Chim Acta 2001;307:205–9.
2. Kilpatrick ES, Rumley AG, Myint H, Dominiczak MH, Small M. The effect of variations in haematocrit, mean cell volume and red blood cell count on reagent strip tests for glucose. Ann Clin Biochem 1993;30:485–7.
3. Rao LV, Jakubiak F, Sidwell JS, Winkelman JW, Snyder ML. Accuracy evaluation of a new glucometer with automated hematocrit measurement and correction. Clin Chim Acta 2005;356:178–83.
4. Stahl M, Brandslund I. Measurement of glucose content in plasma from capillary blood in diagnosis of diabetes mellitus. Scand J Clin Lab Invest 2003;63:431–40.
5. Chan AY, Swaminathan R, Cockram CS. Effectiveness of sodium fluoride as a preservative of glucose in blood. Clin Chem 1989;35:315–7.

Received June 30, 2006, accepted July 28, 2006