The evaluation of Accu-Chek Inform II® and Hexokinase Method in Emergency Departments for Glucose Measurement

Acil Servislerde Kan Glukoz Sonuçlarının Glukometre ve Referans Heksokinaz Yöntemi ile Karşılaştırılması

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ABSTARCT

Objective: Glycemic control has a critical role especially in surgical and medical intensive care units and emergency departments (ED), so point-of-care (POC) glucose monitoring has become increasingly important. The aim of our study was to compare the glucose levels of emergency patients, measured with the Accu-Chek Inform II® and hexokinase reference method.
Methods: One-hundred-four patients' glucose levels were studied with hexokinase method in Abbott Architect C16000 device and Accu-Chek Inform II®. The results were analyzed with Error Grid method. Agreement between the systems was assessed using Bland- Altman and Passing-Bablok regression analysis.
Results: Among 104 patients, the mean participant age was 43.6 ± 15.7 years. Mean glucose levels measured with Accu-Chek Inform II® glucose and reference method were 180.67mg/dL ± 12.57 and 194.26mg/dL ± 14.55, respectively. There was no statistically significant difference between the groups (P>0.05). These two systems' R^2 value was found to be 0.967 (95% CI, 0.952-0,977). The regression equation was Y=9,46+0.88213X. The error grid analysis showed that 98% of the results fell in the Zone A (89%) and Zone B (9%). Two percent of the results was located in Zone C.
Conclusion: The performance of the Accu-Chek Inform II® System was found to be reliable according to currently used reference methods in central laboratories.

Key Words: Error grid analysis, glucose, hexokinase, point of care testing

ÖZET

Amaç: Acil servisler ve yoğun bakım ünitlerinde kan şekeri düzeyinin, hızlı ve doğru tayinin, hastaların tanısı, tedavisi ve takibinde kritik bir öneme sahip olması nedeniyle hasta başı test sistemi (POC) glukometrelerin kullanımı, giderek önem kazanmaktadır. Bizim bu çalışmada amacımız, acil servis hastalarında hastane tipi glukometre sonuçları ile referans metod heksokinaz ile çalışılan kan şekeri sonuçları arasındaki uyumluluğu değerlendirmektir.
Materyal ve metod: 104 hastanın glukoz düzeyi heksokinaz yöntemi ile Abbott Arcitecht C16000 cihazı ve Accucheck Inform II® ile ölçüldü. Sistemler arasındaki uyumluluğa Bland- Altman ve Passing-Bablok regresyon analizi ve Error Grid analizi ile bakıldı.
Bulgular: 104 hastann yaş ortalaması 43.6 ± 15.7 yıldı. Accucheck Inform II cihazında ve referans yöntem ile elde edilen ortalama glukoz seviyeleri sırasıyla 180.67mg/dL ± 12.57 ve 194.26mg/dL ± 14.55 idi. Gruplar arasında istatsitiksel anlamlı fark bulunmadı (P>0.05). Her iki sistemin korelasyonunda R^2 değeri 0.967 (%95 CI, 0.952-0,977) olarak izlenirken regresyon denklemi Y=9,46+0.88213X olarak hesaplandı. Error grid analizinde hastaların %89'u A, % 9'u B, %2 'si C bölgesi'nde izlenmiştir.
Sonuç: Referans yöntem ile karşılaştırıldığında hastane tipi glukpmetre sistemi sonuçlarının hastaların % 97'sinde uyumlu ve klinik sonuçlarına etkilerinin güvenli olduğunu bulunmuştur.

Anahtar Sözcükler: Error grid analizi, glukoz, hekzokinaz, hasta başı testi

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INTRODUCTION

After the findings showing that the glycemic control plays a critical role both for assessing hypoglycemia as well as hyperglycemia, point-of-care (POC) glucose monitoring has become increasingly important (1). The POC glucose monitoring system is especially used in surgical and medical intensive care units and emergency departments (ED) which need to ensure a strict glycemic control with accurate and fast results (2). Plasma and serum samples are often used for the measurement of glucose concentrations in the routine clinical laboratory with auto-analyzers. However, at the POC setting, glucose analysis is usually performed on the whole blood obtained from the capillaries in the finger (3). It is well known that differences exist between glucose levels in the whole blood and plasma (4). In the routine clinical laboratory, to avoid misinterpretation the Internal Federal Clinical Chemistry (IFCC) recommends a constant factor of 1,11 for the conversion of whole blood values into plasma-equivalent values (plasma=whole blood×1.11) (2,5), and the glucometers give venous-calibrated results even they use capillary samples. Various glucometers have various glucose sensor systems and analytical performance standards with different inaccuracy and imprecision levels (6). The accuracy of these systems depends on the sample and analysis-related factors. Sample-related factors are Oxygen (O_2) saturation, hematocrit level, presence of reducing substances (salicylate, ascorbate), hydration status of the patient, altered viscosity (elevated lipids, hemolysis, anticoagulants), processing delay (ongoing glycolysis in laboratory sample), whereas the analysis-related factors are different enzymatic methods, expired or improperly stored test strips, and improper glucose meter use (7). Therefore, accuracy needs to be ensured for the glucose monitoring systems in determining appropriate blood glucose levels in ED patients.

The objective of our study was to evaluate the glucose levels of emergency patients, measured with the Accu-Chek Inform II® POC glucose meters, and to determine their precision, and the bias relative to serum glucose concentrations measured in central laboratories with hexokinase reference method.

METHODS

Subjects and procedures

From January to March 2014, 8763 patients who came to our ED were scanned. Among them, 104 patients (age > 18, 67 women 37 men) who demanded glucose monitoring and hemogram were included in the study excluding children and pregnant patients. In our ED standard protocol for glucose levels measurement, capillary and venous blood samples were used at the same time. The subjects who had the hematocrit value within the normal range, and had both capillary and venous glucose results were included in the current study. Capillary specimens were obtained from the palm side surface of the end of a finger. And venous blood was collected immediately in tubes (BD vacutainer SST™ II Advance tube, Plymouth, UK and BD vacutainer® K2E tube, Plymouth, UK) from antecubital vein. The samples were sent to the laboratory in 10 minutes. Afterwards, a centrifugation test was performed with the reference method.

Analyzers

The POC analyzers evaluated in the retrospective study was Accu-Chek Inform II® (Roche Diagnostic, Mannheim, Germany) system for capillary glucose. The Accu-Chek Inform II® system quantitatively measures glucose in the whole blood with glucose dehydrogenase. The system is calibrated with venous blood containing various glucose concentrations, and is calibrated to deliver plasma-like results. The Accu-Chek Inform II® quality control solutions in the low and high range were used every time a new vial of glucose strips was opened or approximately once a week.

Venous blood glucose was measured with Abbott Architech C16000 (Abbott, Chicago, USA) auto-analyzer in the central laboratory which used hexokinase reference method. Inter-assay precision studies were performed as recommended by National clinical Chemistry Laboratory standards (NCCLS) (8). The hematocrit levels were measured with Bayer Advia 2120 (Siemens Diagnostic, Munich, Germany).

Statistical analysis;

Glucose levels obtained from POC systems and the reference method were compared for descriptive statistics on SPSS 14.0 (SPSS Inc, Chicago, IL). Two Student t-tests were used to evaluate the difference between the groups. P < 0.05 was considered statistically significant.

EP 5 evaluator was used for the Error Grid analysis, and 5 different zones were obtained for the comparison of the glucose levels which reflect the medical risk of the error (9,10). Paired values fell in five zones. In Zone A, the test and the reference method agree within 20%, and there is no effect on the clinical action. In Zone B, the test and the reference method differ by >20%, prompting an altered clinical action, but there is little or no effect on clinical outcomes. In Zone C, the over-correction is likely to affect clinical outcomes. Zone D reflects a significant medical risk. Means detected and treat blood glucose levels exceed the desired target range. Finally in Zone E, the correction is in the wrong direction and dangerous consequences can be observed due to values' being opposite to the actual values in this zone (hypoglycemic result from a hyperglycemic individual and vice versa). The test performance is typically considered acceptable if > 95% of points fall within zones A and B, and no or negligible points fall in zones D and E (6,7,11).

Agreement between the POC method and the reference method was assessed using Bland- Altman and Passing-Bablok regression analysis (12) with Microsoft Office Excel 2010. The bias was assessed by testing the hypothesis that the slope of the regression of glucose measurements was equal to 1 (indicating that the values were identical).

RESULTS

Among 104 patients, the mean participant age was 43.6 ± 15.7 years. There were 37 men (35.6%) and 67 women (64.4%). The hematocrit level of the entire group was 36.3 ± 4.5. The study group had wide ranges of glucose levels. Mean glucose levels measured with Accu-Chek Inform II® glucose and reference method were 180.67 ±12.57 mg/dL and 194.26 ± 14.55 mg/dL, respectively. With a Student t- test, statistically significant difference was not observed in glucose results between the groups (P>0.05). The median values of glucose with Accu-Chek Inform II® and the reference system were 118 mg/dL (15-543 mg/dL) and 123mg/dL (5-688 mg/dL), respectively. The graphs of these results were shown in Figure 1. Obtained coefficient variation (Cv) levels from Accu-Chek Inform II® and the reference method for low and high control were 2.8%, 4.2% and 3.1%, 3.6%, respectively. Both of the systems had satisfactory imprecision with the use of low and high control materials. When we correlate these two systems, R^2 value was found to be 0.967 (95% CI, 0.952 - 0,977) and the graph is shown in Figure 2. The linearity was acceptable for the Accu-Chek Inform II® system. Bland-Altman analysis was performed, and the bias and the corresponding limits of agreement was investigated. The intercept was 9,46 (95% Cl 4.64 to 13.46) and the slope was 0.88 (95% Cl 084 to 0.91). The regression equation was Y=9.46 +0.8821X, which is also shown in Figure 3. Bland-Altman analyses showed good correlations between the result of Accu-Chek Inform II® and the reference method. Error grid analysis showed that 98% of the results fell in Zone A (89%) and Zone B (9%) which were clinically acceptable. Two percent of the results was located in Zone C. There was no result in Zone D or Zone E (Figure 4). Results of the error grid analysis were in accordance with the results of regression and correlation analyses in our study. Based on these results, the test performance can be said to be acceptable.

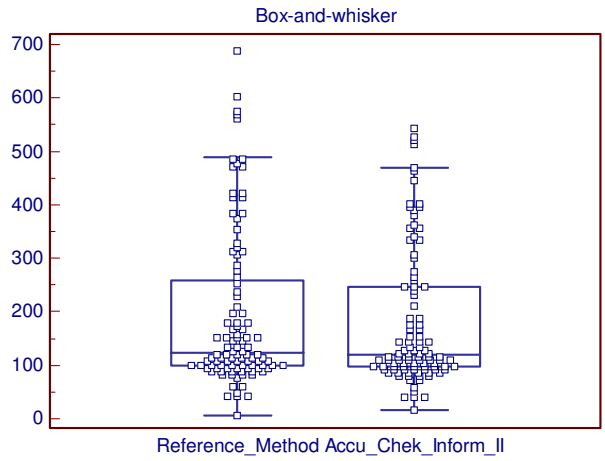

Figure 1. Glucose levels obtained from Accu-Chek Inform II® and with reference method were shown with box and whisker graph. All results are in mg/dL.

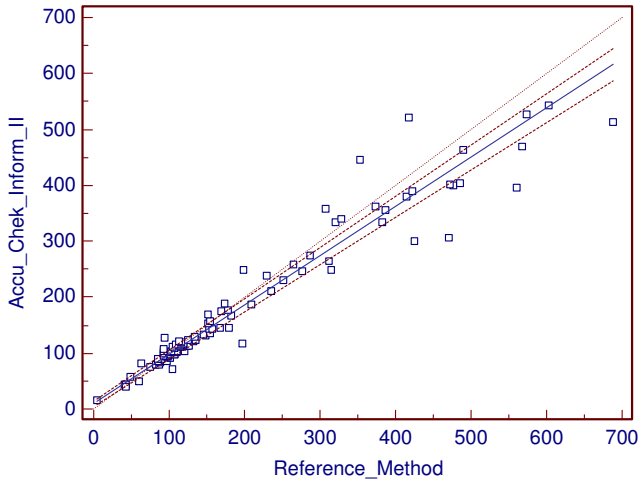

Figure 2. Linear regression analyses of reference hexokinase method and Accu-Chek Inform II® System obtained from 104 samples

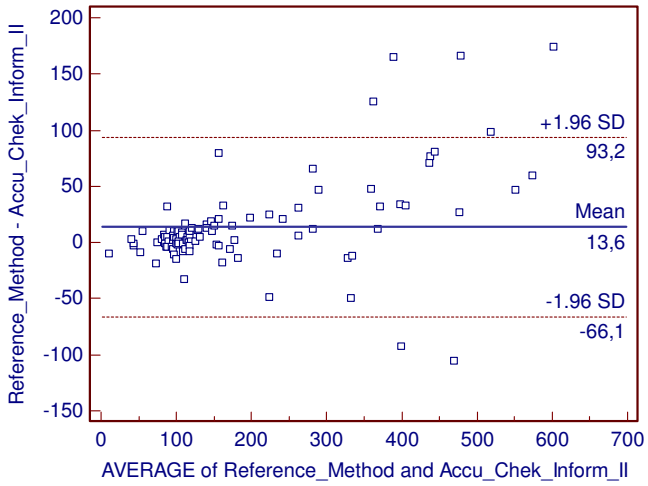

Figure 3. Bland-Altman plot between Accu-Chek Inform II® System and the reference hexokinase method in 104 samples in ED. The bias (or mean difference) and the limits of agreements are shown in the figure.

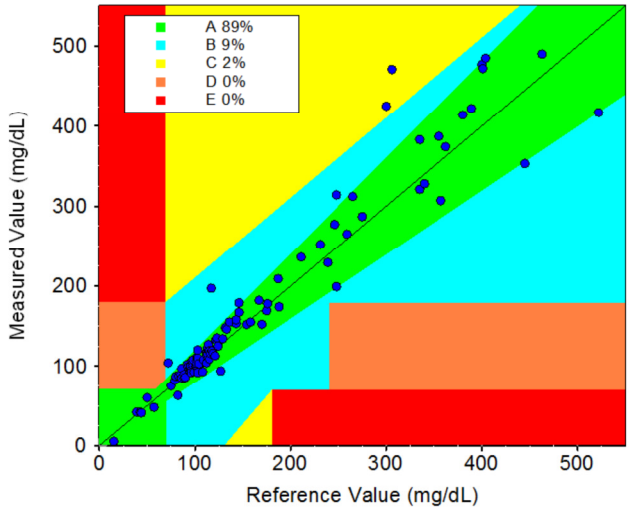

Figure 4. Error Grid analyses of reference hexokinase method and Accu-Chek Inform II® System results obtained from 104 patients. 89% of the results were in Zone A, 9% of the results in Zone B and 2% of the results were in Zone C whereas no result was located in Zone D and Zone E. 98% of the results was in acceptable limits.

DISCUSSION

POC glucose testing in EDs is widely established. The fast and accurate glucose results need to be closely monitored to prevent mortality and morbidity, especially in the emergency settings. Although POC uses relatively decreased amounts of blood for testing and needs reduced total turnaround time (TAT), these systems have more inferior analytical performance than glucose assays in clinical laboratories(1). It is important, to avoid the failure to treat underlying hypoglycemia or hyperglycemia due to placing the patient at risk for potential neurological complications. In our study, the ED POC systems accuracy was tested with clinical laboratory reference hexokinase system.

When we compare the methods with the Bland Altman, the difference of the two methods did not show a significant range of blood glucose levels. Our findings were similar with the other studies in the literature, which were not significantly different from median laboratory plasma glucose levels and provided accurate results. (13,14). On the other hand, recent studies found results that are different from ours (15,16). There was a small but significant difference in the blood glucose results analyzed on a bedside glucometer when the samples are taken from capillary or venous sources. (15,16). It was concluded that there was a poor correlation between capillary and venous blood glucose estimations using glucometers designed for capillary samples. (15,16). Also Sylvain et al. (17) found significantly different results between these sample types in shock patients who had poor perfusion. These differences may arise from sample-related factors due to the vascular and hemodynamic status of critically ill patients' being selected from ICUs which may have had some problems with obtaining capillary samples.

In the current study, error-grid analysis demonstrated that 98% of the results fell in zone A and B. Our findings are similar with those of Brunner et al. (18) and other researchers (11,14,19,20) who found over 99.7% of the results to be in zone A and B when they compared POC systems with glucose hexokinase or glucose oxidase methods. These results suggest that Accu-Chek Inform II® is a reliable glucometer for measuring capillary glucose levels in ED. On the other hand, we found 2% of the results in zone C. The two patients in zone C had glucose results with POC system as 300 and 306 mg/dL while with the reference hexokinase methods the values were 425 and 471 mg/dL, respectively. These differences may have no effect onpatient outcomes. Therefore Accu-Chek Inform II® as compared with the reference method can be safely used in hyperglycemic patient groups.

There are some limitations to our study caused by the limited knowledge about patient O_2 saturation, hydration and viscosity status, and the existing interfering substances that are affecting the measurement of these automatic glucometers. On the other hand, our study group included both hypoglycemic, normoglycemic and hyperglycemic, results and number of the samples was sufficient according to what was recommended by the ISO15197 (21).

CONCLUSION

The performance of the Accu-Chek Inform II® system was found to be reliable when compared with currently used reference hexokinase method in the central laboratories, and can be safe to use in clinical departments as well as EDs. In addition to that fact that this POC system was providing accurate and fast results with a small sample size, it was an easy instrument to use. Using at least two level control solutions would prevent any erroneous results if the control solution results were within the manufacturer's reference values. The risk of an improper use of the instrument and the test strips, was an issue that must not be forgotten, and the glucose measurement should be interpreted with caution especially for critically ill patients.

Conflict of Interest

No conflict of interest was declared by the authors.

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