Accuracy of Glucometer for measuring blood glucose in diabetic and ICU patients

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Abstract

To determine the association between blood glucose measured by Glucometer and standard laboratory methods (Glucose oxidase in automated analyzer) in diabetics and patients hospitalized at intensive care unit (ICU). Blood samples of 100 diabetics and 20 ICU patients in Sanandaj city western Iran were analyzed. The capillary blood glucose levels of patients as determined by Glucometer with venous blood glucose levels measurements by the enzymatic method (Glucose oxidase, the standard laboratory kit) were compared. Mean blood glucose measured by Glucometer and standard method in diabetics was 149.58 ± 50.86 mg/dl and 163.86 ± 60.69 mg/dl respectively. The corresponding rates for ICU patients were128 ± 39.6 mg/dl and 115.55 ± 37.48 mg/dl respectively. Correlation between bed side glucometer and laboratory automated analyzer for glucose values was less in the ICU patients (r = 0.732, p<0.01 vs. r = 0.983, p<0.01). Mean Turnaround time for glucometer and automated analyzer were 0.07 hours and 2.2 hours respectively. Glucometer is a safe, cost-benefited, feasible and reliable instrument for measuring blood sugar in outpatients in particular. Hence, caution must be exercised especially in ICU patients.

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Introduction

Improvement of medical procedures is always conducted to obtain favorable clinical results. "Diagnostic Testing" that is performed near or at the site of patient care, have major advantages as the time saving and management decisions. Glucometers are widely used to investigate the current blood glucose levels for both inpatient and out patients [1].

Many studies have shown that exact control of blood sugar level in patients with diabetes at home or outpatient could prevent of disease progression and complications. But it does not seem to realize this goal without the use of glucometer [2]. In the other hand blood glucose monitoring in critically ill patients hospitalized in the ICU is essential and reduces mortality significantly [3-5].

Accuracy of glucometer performance is an important concern of clinicians, because it has 10-15% error in best situation. The accuracy and performance is affected by different factors [6].

Therefore, the present study was conducted to compare the accuracy of capillary bedside glucometry and Standard Laboratory Method among critically ill patients in ICU and diabetic patients.

Materials and Methods

Overall, 120 patients including 100 diabetics attending diabetes clinics in Towhid Hospital, Sanandaj, Iran and 20 ICU patients were included in the study. The study was undertaken at the Department of Pathology, Faculty of Medicine, Kurdistan University of Medical sciences, from January 2010 to August 2010. It was compared the capillary blood glucose levels of patients as determined by test strips (Glucometer ACCUA CHECK) with venous blood glucose levels measurements by the enzymatic method (Glucose oxidase, the standard laboratory method).

A drop of blood was applied to the electrode/strip (provided by the manufacturer, having lot number and expiry date) by a trained nurse and the reading was noted on digital window of glucometer. At the same time three milliliter of blood was obtained by venepuncture in a tube containing Sodium fluoride as preservative. The tube was marked for identification and transported to hospital laboratory. Plasma was separated by centrifugation, at a speed of three thousand rounds per minutes for a period of five minutes with a relative centrifugal force of 1400 (rcf) and was analyzed on

automated analyzer (PRESTIGE 24I) by glucose oxidase method.

Statistical analysis was done using SPSS (version 16.0) software. Correlation Coefficients were calculated to find the relation between the two methods. Data was analyzed by dividing patients into two groups (inpatient and outpatient).

Results

Data from 100 outpatients and 20 ICU patients were analyzed. The patient characteristics are compared in Table 1. Figure 1 shows a mean absolute difference, between two methods, for two groups (inpatients and outpatients). A total of 120 patients (100 outpatients, 20 ICU patients) were enrolled in the study. More than three-fourths (77.5%) of them were females. The average age of patients was 58 years (ranged between 21 to 90 years; Median age = 57 years), (Table 1).

A significant difference was observed between the two groups of patients ($p<0.01$). It was observed that glucometer readings were higher as compared to standard method readings for diabetic patients and were lower than standard method for ICU patients.

There was a significant correlation between the standard method and glucometer measurements in both the groups but correlation was stronger in outpatient group, $r=0.983$, $p<0.01$ versus $r=0.732$, $p<0.01$ for ICU group (Figures 2 and 3).

Mean time for glucose testing with glucometer was 0.07 hours (4.2 minutes). The total cost glucometer test was half price than lab based test owing to the additional cost incurred by the lab such as space, manpower and utilities.

Discussion

In the present study, fasting blood sugar in 100 outpatients referred to the diabetes clinic and random blood sugar of 20 patients hospitalized in the ICU were measured by glucometer and standard laboratory tests (Centralized glucose testing). In both groups correlation was observed between two methods. A Pakistani study has already reported a good correlation between bed side glucometer and laboratory automated analyzer for glucose values between 60 mg/dl and 300 mg/dl [1]. This confirms our results because our patients had blood glucose in these range, only two patients had blood glucose outside.

We observed that diabetes clinic outpatients were under estimated for fasting blood glucose results when tested with glucometer in the range 60 - 300 mg/dl (mean difference =-14.29 mg/dl). On the other hand glucose values were overestimated with glucometer in patients whom hospitalized in the ICU. (Mean difference =12.45 mg/dl). This issue shows variations between glucometer and laboratory values despite good correlation. A recent study has shown that despite the error performance of glucometer to use, it can be a useful way for controlling blood sugar at home [7]. This confirms our results. Another study showed that glucometer estimation was similar to the laboratory measurement in the midranges of glucose values in children with shock [8]. For adult ICU patients, the reliability of glucometer was revealed only in selected group and caution must be exercised in patients with shock in whom arterial blood may be preferred [9]. On the other hand, in a study that compared four different methods of glucose measurement, it was shown the poor performance in critically ill patients, as clinical agreement with the central laboratory less than 80% [10]. A study was performed in 2007 on 49 critically ill patients that has examined the agreement between point-of-care and laboratory glucose values showed that, Glucose values for point-of-care samples did not differ significantly from laboratory values [11].

Glucometer is a safe, cost-benefited, feasible and reliable instrument for measuring blood sugar in outpatients in particular. Hence, caution must be exercised especially in ICU patients.

Acknowledgement

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Table 1. The patients' characteristics (mean ± SD*)

Patients' characteristics	Diabetics	ICU	All
n	100	20	120
Gender (M/F)	16/84	11/9	27/93
Age (year), mean (SD)	56.9 (12.6)	63.8 (16.35)	58 (13.5)
Mean difference (mg/dl)	14.29	-12.45	9.83

ICU: Intensive Care Unit
*Standard deviation

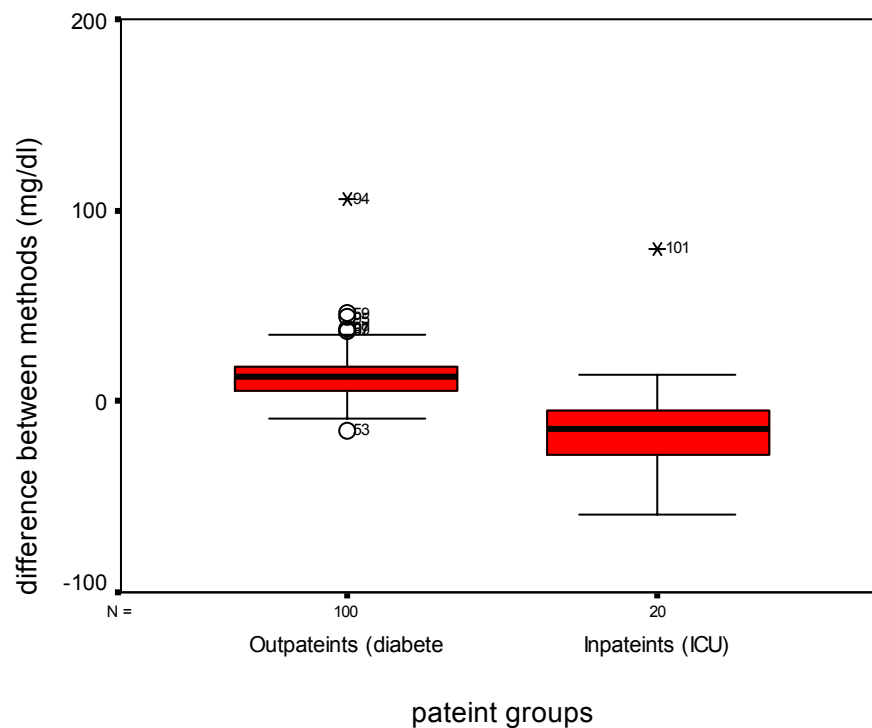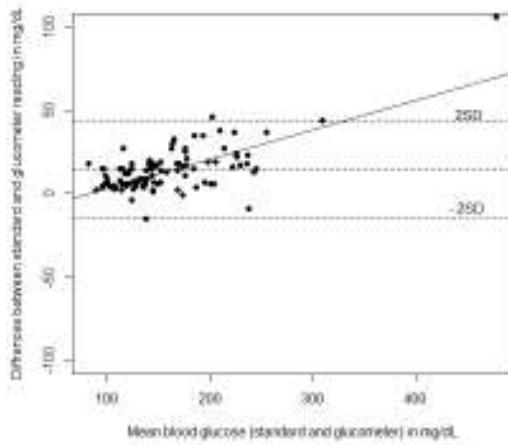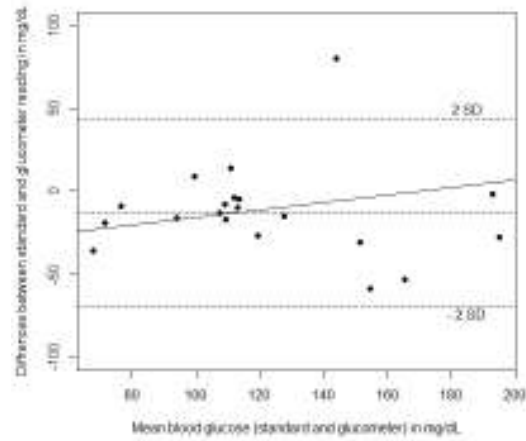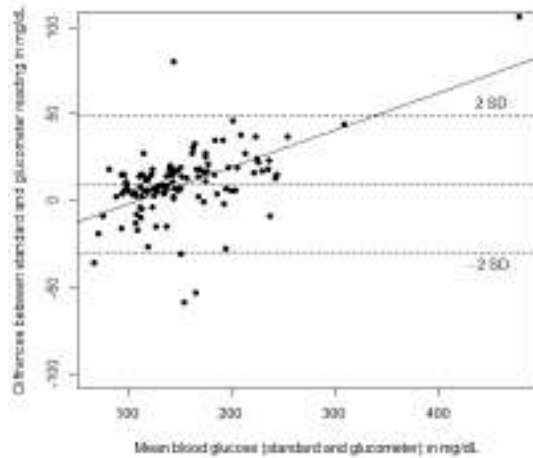**Figure 1.** Box plot of difference (mg/dl) between methods for two groups

Figure 2. Bland-Altman plot of the difference between finger stick and laboratory blood glucose measurements in outpatient's diabetes clinic (a), inpatients ICU patients (b), and all of patients (c). The horizontal lines mark the mean and the 95% CI of the differences between paired measurements. The 95% CI correspond to the limits of agreement.

2.a

2.b

2.c