Original Article

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Comparison of Point of Care (POC) Testing of Glucose by B Braun Glucometer and Hemocue Glucose 201+ Analyser Versus Centralised Testing in Neonatal Intensive Care Unit (NICU)

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ABSTRACT

Background: Neonatal hypoglycemia is the most common carbohydrate metabolic disturbance seen in case of neonates and especially in preterm neonates. Accurate and rapid determination of hypoglycemia and its prompt treatment is of utmost importance to decrease morbidity and mortality of neonates.

Aims: To estimate blood glucose in neonates and test the efficacy of HemoCue Glucose 201+ analyser and B Braun Glucometer by comparing with centralised laboratory testing. To compare the blood glucose in capillary and venous blood samples of neonates.

Settings and Design: Hospital setting; Comparative Study

Materials and Methods: After obtaining informed consent, all neonates admitted to Neonatal Intensive Care Unit (NICU) were screened for blood sugar. Capillary and venous blood glucose was estimated employing HemoCue Glucose 201+ analyser and B Braun Glucometer. Simultaneously, the same venous sample was collected in fluoride tube and sent to central clinical biochemistry laboratory for glucose estimation. When anaemia or polycythemia was clinically suspected the same venous sample was sent for estimation of Hematocrit (Hct).

Statistical Analysis: Comparison of blood glucose concentration of B Braun glucometer, HemoCue Glucose 201+ analyser and centralis/ed plasma glucose levels was done by using students test. All the statistical analysis were done using software SPSS 6 version.

Results: Mean values of blood glucose (100.2 $\pm$ 48.4) with B Braun glucometer was significantly higher (p=0.003) when compared to plasma glucose values (76.95 $\pm$ 45.99) estimated in central laboratory and HemoCue glucose 201+ analyser (82.9 $\pm$ 51.4). HemoCue glucose 201+ analyser did not show significant difference (p=0.463) with central laboratory testing. There was no significant difference between the capillary and venous sample estimated in both the instruments. Estimation with HemoCue glucose 201+ analyser correlated well with central laboratory testing in neonates with blood glucose <55mg/dl,

Conclusion: We conclude that HemoCue glucose 201+ analyser appears to be a suitable point of care (POC) blood glucose measurement device in neonates on both capillary and venous blood samples, as it showed a good correlation with central laboratory values without significant interference from Hct.

Keywords: B Braun glucometer, Blood glucose, HemoCue glucose 201+ analyser, Point of care testing

INTRODUCTION

Bedside or point of care (POC) glucose testing in the neonatal intensive care unit (NICU) is widely used to provide immediate care to the neonate. Neonates are vulnerable to disturbances in glucose metabolism particularly hypoglycemia. Both preterm and term neonates are at risk for adverse neurodevelopmental outcome with prolonged hypoglycemia [1]. Hence, accurate and rapid determination of hypoglycemia and its prompt treatment is of utmost importance to decrease morbidity and mortality of neonates.

Laboratory estimation of plasma glucose has been considered as the optimum method for measuring blood glucose. Although, there is no universally agreed reference methodology for blood glucose measurement, the hexokinase method is generally recommended [2]. The other enzyme methods used by laboratory analysers include glucose oxidase or glucose dehydrogenase (GDH). The major drawbacks of laboratory based estimation are the need for a larger volume of blood and delay in obtaining results for timely appropriate treatment [3]. Hence the widespread use of POC glucose testing devices in NICU. There are many glucometers available to measure glucose in bedside. But these glucometers were initially developed for glucose monitoring in adult patients with diabetes [4]. As with other medical devises glucometers do have certain limitations. Performance and accuracy of results are affected by environmental factors, operator's interference, patient condition, drugs, type of sample used, methodology used in blood glucose estimation and many metabolic factors [5]. Various studies have compared results between glucose meters of different manufacturers with variable results in neonatal units [6-11]. However, testing of performance of glucometers in neonates is challenging as test results can be affected by hemoglobin concentration and packed cell volume. In general whole blood glucose concentration are 10-15% lower than plasma glucose measurement [4].

The HemoCue Glucose 201+ analyser was recently introduced in our NICU for bedside blood glucose estimation. This instrument has special features of storing results upto 600 tests and capillary, venous, arterial whole blood can be used for the assay. Hence, we undertook this study to evaluate the clinical performance of portable HemoCue Glucose 201+ analyser and compare the results with the currently used B Braun glucometer and central laboratory blood glucose measurement.

MATERIALS AND METHODS

After obtaining approval by our institutional ethics committee, the study was conducted from September 2012 to November 2012. All neonates (preterm and term) admitted to NICU were included in the study. As determination of glucose is part of routine clinical procedure for neonates admitted to NICU, individual specific consent was not obtained.

Both symptomatic and asymptomatic neonates were screened for whole blood glucose levels at the time of admission into NICU. During insertion of intravenous line, venous sample was tested for blood glucose using B Braun glucometer and HemoCue Glucose 201+ analyser. The same venous sample was collected in fluoride tubes and sent to central clinical biochemistry laboratory for plasma glucose measurement. The analysis was done on emergency basis within half an hour of collection of blood sample. Simultaneously, a heel prick (capillary) sample was obtained and blood glucose was assessed using both B Braun glucometer and HemoCue Glucose 201+ analyser. When anaemia or polycythemia was clinically suspected the same venous sample was sent for estimation of Hematocrit (Hct).

In our institute plasma glucose in the central clinical biochemistry laboratory is measured by Glucose Oxidase and Peroxidase method in vitros 250 Johnson and Johnson dry chemistry analyser. The oxidation of sample glucose is catalyzed by glucose oxidase to form hydrogen peroxidase and gluconate. This reaction is followed by an oxidative coupling catalyzed by peroxidase in the presence of dye precursors to produce a dye. The intensity of the dye is measured by reflected light [12]. Routine quality control check was followed for the analysis. B Braun glucometer also utilizes glucose oxidase peroxidase method for estimation of capillary glucose [12].

HemoCue Glucose 201+ analyser consists of specially designed cuvettes containing dried reagents. The cuvette serves as a pipette, reaction vessel and as a measuring cuvette and no dilution is required. HemoCue Glucose 201+ analyser estimates blood glucose by two step GDH reaction principle. Saponin hemolyses the erythrocytes and the contents are released. α-D-glucose is transformed to β-D-glucose using the mutarotase enzyme. GDH enzyme specific for β-D-glucose acts as a catalyst in the oxidation of β-D-glucose in the presence of Nicotinamide adenine dinucleotide (NAD) to form NADH. The GDH/mutarotase enzyme system ensures a molar relationship between the available glucose and NADH produced. In the presence of NADH, using diaphorase as a catalyst, the MTT chromogene (a tetrazolium salt) is formed to a colored formazan. The colored formazan is quantified photochromatically with a two-wave length method (660 and 840 nm) [13]. A calibrated check using the manufacturer supplied control cuvette was performed once a day on the HemoCue Glucose 201+ analyser. Glucose measurement in both B Braun glucometer and HemoCue Glucose 201+ analyser was carried out by a trained nursing staff. All the safety and standardized guidelines for sample collection was followed.

STATISTICAL ANALYSIS

Descriptive data is represented in mean and standard deviation. Comparison of blood glucose concentration of B Braun glucometer, HemoCue Glucose 201+ analyser and centralized plasma glucose levels was done by using students test. All the statistical analysis were done using software SPSS 6 version.

RESULTS

A total of 73 neonates were enrolled in the study, of which 53 (73%) were term and 20 (27%) were preterm. Majority (85%) of them were born outside and referred to our NICU for hospitalization. Gestational age of neonates ranged from 31 weeks to 40 weeks and birth weight ranged from 1,100 grams to 4,200 grams. Hct estimated in 25 neonates showed a wide range (35%-60%).

The relationship between capillary blood glucose values of B Braun glucometer and HemoCue glucose 201+ analyser with central laboratory plasma glucose values is shown in [Table/Fig-1]. Mean values of blood glucose (100.2 ± 48.4) with B Braun glucometer was significantly higher (p=0.003) when compared to plasma glucose values (76.95 ± 45.99) estimated in central laboratory. However, blood glucose levels (82.9 ± 51.4) estimated by HemoCue glucose 201+ analyser did not show significant difference (p=0.463) with central laboratory testing.

[Table/Fig-2] depicts the mean values of blood glucose in different types of samples estimated by both the devices. Mean values of blood glucose estimated in capillary and venous blood by HemoCue glucose 201+ analyser was 82.9 ± 51.4 and 84.96 ± 47.75 respectively which was not statistically significant (p=0.80). Similarly, mean values of blood glucose estimated in capillary (100.2 ± 48.4) and venous blood (96.71 ± 48.26) by B Braun glucometer did not show any statistical significance (p=0.65). Mean value of blood glucose (66.33 ± 21.6) estimated by B Braun was significantly higher (p=0.02) when compared to mean values of blood glucose (42.26 ± 5.7) estimated by HemoCue Glucose 201+ analyser. Similarly, mean value of blood glucose (66.33 ± 21.6) estimated by B Braun was significantly higher (p=0.03) when compared to mean values of blood glucose (41.8 ± 5.4) estimated by auto analyser in central laboratory. Meanwhile, blood glucose levels (42.26 ± 5.7) estimated by HemoCue Glucose 201+ analyser was not statistically significant (p=0.95) when compared to auto analyser in central laboratory (41.8 ± 5.4). Fifteen neonates had plasma glucose levels in the lower range (< 55mg/dl) when tested in central laboratory. A comparison was done with the 15 samples as shown in [Table/Fig-3].

Instrument	Number	Mean±SD	Comparison	t- value	p-value
B Braun (capillary blood)	73	100.2 ± 48.4	B Braun (capillary) Vs Auto analyser	2.98	0.003*
HemoCue glucose 201+ analyser (capillary blood)	73	82.9 ± 51.4	HemoCue glucose 201+ analyser Vs Auto analyser	0.737	0.463
Autoanalyser	73	76.95 ± 45.99			

[Table/Fig-1]: Comparison of blood glucose values using b braun glucometer and HemoCue glucose 201+ analyser with centralized laboratory testing

Instrument	Mean ±SD	Comparison	t- value	p-value
HemoCue glucose 201+ analyser (capillary)	82.9 ± 51.4	Hemo Cue glucose 201+ analyser (capillary) Vs HemoCue glucose 201+ analyser (Venous)	0.25	0.80
HemoCue glucose 201+ analyser (Venous)	84.96 ± 47.75			
B Braun (capillary)	100.2 ± 48.4	B Braun (capillary) Vs B Braun (Venous)	0.44	0.65
B Braun (Venous)	96.71 ± 48.26			

[Table/Fig-2]: Comparison of blood glucose levels in different types of blood samples

Instrument	Number	Mean ±SD	Comparison	p-value
B Braun (capillary)	15	66.33 ± 21.6	B Braun (capillary) Vs HemoCue glucose 201+ analyser	0.002*
HemoCue glucose 201+ analyser (capillary)	15	42.26 ± 5.7	HemoCue glucose 201+ analyser Vs Autoanalyser	0.95
Autoanalyser	15	41.8 ± 5.4	B Braun (capillary) Vs Autoanalyser	0.003*

[Table/Fig-3]: Comparison of blood glucose values among POC devices and central laboratory testing in low glucose range

DISCUSSION

In hospital settings, particularly NICUs, glucose levels are assessed very frequently and sending a blood sample each time for confirmation to the laboratory would add to the discomfort and expense. POC testing glucometers are widely used as an initial screening tool to estimate blood glucose levels for rapid assessment and prompt intervention pending central laboratory values. POC testing is defined as any analytical testing done outside a designated laboratory space. It has many advantages like rapid turnaround time, reduced blood volume requirement, and clinical utility over traditional laboratory based testing. It is well understood that currently used glucometers were initially developed for glucose monitoring in adult patients with diabetes and results were well-correlated with gold standard laboratory testing in normoglycemic and hyperglycemic blood glucose levels. But our concern is accuracy of results in lower blood glucose levels which is very often in neonates [14]. Due to these accuracy issues we tried to compare two POCT devices HemoCue Glucose 201+ analyser and B Braun glucometers with gold standard centralized laboratory measurement.

In our study we did not find any significant statistical difference between HemoCue glucose 201+ analyser and central laboratory values over a wide range of glucose levels – [Table/Fig-1]. We further compared the two POC devices in the low glucose range (<55 mg/dl) and found no significant statistical difference between HemoCue Glucose 201+ analyser and central laboratory values – [Table/Fig-3]. Based on the above observations, we found that determination of blood glucose with HemoCue Glucose 201+ analyser had very good correlation with central laboratory testing over a wide range of glucose levels in general and in low glucose ranges in particular. There has been discussion in the literature on the accuracy of HemoCue glucose system in neonates [15-18]. The HemoCue method was reported to have several advantages in the analysis of glucose in newborns such as short analysis time, small sample size, and no influence from glycolysis. However, falsely low values were observed especially in the low measuring range as reported by Dahlberg M et al., [15].In other studies it has been observed that HemoCue overestimated plasma glucose levels and thus it was an unsuitable device in the management of glycemia in the NICU [16,18]. On the other hand, Deshpande et al., [6] have observed that HemoCue system offered the best available compromise between bedside and laboratory glucose estimation in the neonate which is in agreement with our study. There was also reasonable agreement in another study employing HemoCue system in neonates [17]. HemoCue analyser demonstrated superior precision and accuracy in determining blood glucose levels particularly, hypoglycaemia in the adult population [19]. Yet in another recent study on both pediatric and adult hospital patients, the results of three bedside glucometers were compared with laboratory results and it was reported that HemoCue analyser along with two other POC devices compared with plasma glucose measurements. All the three POC devices measured glucose levels with acceptable precision (co-efficient variation <14%), thus making them suitable for in- hospital use [20].

Confusion exists as to whether capillary or venous blood glucose measurements tested on glucometers are more accurate [21,22]. Glucose concentration is higher in capillary blood than in venous blood and this is much pronounced after glucose load [13]. To overcome this confusion, we compared capillary and venous blood samples employing two portable POC instruments against central laboratory blood glucose levels. Our study did not show any significant statistical difference between the various types of samples – [Table/Fig-2]. This supports the view that blood glucose estimation using venous blood with POC testing devices designed for capillary blood testing is accurate. In NICU, neonates undergo intravenous cannulation immediately on admission which enables venous samples to be more readily available for blood glucose estimation, thereby avoiding painful heel pricking procedure.

It is believed that Hct levels affect glucose measurements by blood glucose [23,24]. In a recent study on premature neonates, accurate glucose results were provided at different Hcts using POC testing device [25]. In our study, Hct was estimated in 25 samples and we did not find any difference in glucose measurements over a wide range of Hct (35%-60%) using HemoCue analyser.

The limitation of our study was the small sample size in the lower glucose range (<55 md/dl). Further studies on a larger sample in low glucose range are needed. Nevertheless, we conclude that HemoCue glucose 201+ analyser appears to be a suitable POC blood glucose measurement device in neonates on both capillary and venous blood samples, as it showed a good correlation with central laboratory values without significant interference from Hct.

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