CODEN [USA]: IAJPBB ISSN: 2349-7750

INDO AMERICAN JOURNAL OF
PHARMACEUTICAL SCIENCES
http://doi.org/10.5281/zenodo.3732522

Available online at: http://www.iajps.com *Research Article*

ACCURACY OF BEDSIDE BLOOD GLUCOSE ESTIMATION BY GLUCOMETER USING CAPILLARY AND VENOUS BLOOD SAMPLES

Ahmad Shehzad[1], Ahmad Riaz[2], Muhammad Husnain[3], Ahmad Usman[4]

[1]Department of General Medicine, Nishtar Medical University and Hospital, Multan, Email address: ahmadshehzad27@gmail.com

[2]Department of General Surgery, Nishtar Medical University and Hospital, Multan, Email address: ahmedsheih183@gmail.com

[3]Department of General Medicine, Nishtar Medical University and Hospital, Multan, Email address: mhasnainashiq@gmail.com

[41]Department of Orthopedic Surgery, Nishtar Medical University and Hospital, Multan, Email: mrahmadusman@gmail.com

Article Received: January 2020 **Accepted:** February 2020 **Published:** March 2020

Abstract:

Objective: *Determination of the difference and correlation between capillary and venous glucose monitoring by glucometer in comparison to venous glucose analysis by standard laboratory.*

Methods: *The study was conducted on a non-probability convenient sample of 20 consenting patients visiting the emergency department of Nishtar Medical University, Multan. Their blood glucose levels were synchronously analyzed using a bedside On Call Plus glucometer on capillary and venous derived samples. The venous sample was also sent for comparative testing to the central hospital laboratory using Beckman Coulter AU680 Clinical Chemistry Analyzer. Student's t-test and Pearson's correlation analysis was done to determine the difference and correlation of results.*

Results: *The mean age of 20 subjects was 47±5.7. The mean laboratory glucose, mean capillary blood glucometer glucose, and mean venous derived blood glucometer glucose was 127.47, 138.01 and 143.96 mg/dl, respectively. A statistically significant difference (10.45 mg/dl, p=0.001) between the mean values for the laboratory and capillary glucose samples was noted. The difference between the mean values for the laboratory and venous glucometer samples was also found statistically significant (16.39mg/dl, p=0.001). There was a 5.94 mg/dl (p=0.05) difference between the capillary and venous derived glucometer tested samples as well. Thus difference was observed between the glucometer and the laboratory blood glucose results.*

Conclusion: *There is a significant yet small variation in the blood glucose results analyzed by laboratory and glucometer. The difference between capillary and venous glucometer measurement may be clinically small and irrelevant, but caution must be exercised in accepting the results as equivalent or using either as substitutes for the standard laboratory blood glucose results.*

Keywords: *Glucometer, Capillary blood, Venous blood, Laboratory, Accuracy.*

Corresponding author:

Ahmad Usman,

Postal Address: House No.2, Gulgasht Colony, Multan, Punjab, Pakistan.

Email: mrahmadusman@gmail.com

QR code

Please cite this article in press Ahmad Usman et al., ***Accuracy Of Bedside Blood Glucose Estimation By Glucometer Using Capillary And Venous Blood Samples,*** *Indo Am. J. P. Sci, 2020; 07(03).*

INTRODUCTION:

Glycemic monitoring is a commonly performed practice in patients presenting in the emergency department. It helps to screen patients with symptoms suspected to be caused by hypoglycemic or hyperglycemic conditions, facilitating in making decisions regarding their management. With the availability of easy to use, portable, inexpensive, point of care glucose testing devices called the glucometers, the practice of sending venous blood for laboratory estimation of blood glucose has declined. Although laboratory estimation is considered the standard method, the need for a larger volume of blood and delay in obtaining results are its major drawbacks. The glucometers, on the contrary, provide the advantage of portability, cost-effectiveness, and rapid availability of results within seconds in situations where delayed central laboratory results make rapid adjustments in therapy impractical. Most of these meters have established accuracy in stable outpatients. However, they have their limitations as well. For critically ill patients, various confounding factors have been identified that may interfere with their results, including hematocrit level, oxygenation, acid-base disturbances, temperature, shock, and hypo-perfusion states. In such cases, venous sample provides more accurate results [1,2].

This study was carried out with the objective of determining the differences and correlation of capillary and venous bedside glucose estimation by point of care glucometers with laboratory venous glucose analysis in patients presenting in the emergency department.

MATERIALS AND METHODS:

After obtaining approval from the institutional ethical committee, the study was carried out in December 2019, on the medical floor of the emergency department of Nishtar Medical University and Hospital, Multan, Pakistan. The study was done on subjects who were approached using a random non-probability convenient sampling. This sampling method used sequential patients presenting to the emergency department over a random pattern of shifts in order to allow a complete spectrum of patient presentations to be included. The sample size was calculated using power calculation, considering α=.05 and β=0.1. The calculation suggested that 16 patients would be required to detect a 1 mmol/l i.e., 18.01 mg/dl difference in means between the laboratory analyzed and the glucometer tested capillary blood glucose. We included 20 subjects. After obtaining fully informed consent, 5ml peripheral venous blood was withdrawn, and two samples were taken from this. A bedside glucometer analysis was performed from one sample, and the second sample was sent to the central clinical laboratory of the hospital in a lithium heparin tube for venous blood glucose Estimation. A simultaneous capillary finger prick was performed, which was also analyzed using the bedside glucometer by the researchers themselves. The glucometer used was of the company OnCallPlus, which was calibrated and validated against the manufacturer's guidelines was used for all subjects enrolled in the study. The laboratory testing was carried out by Beckman Coulter AU680 Clinical Chemistry Analyzer.

The data collected was recorded and analyzed using SPSS version 25. Student's t-test was used to measure the statistical significance of the difference in means of the three groups. The degree of correlation of the capillary glucose and venous glucose with the laboratory glucose result was tested using Pearson's correlation coefficient. Bland and Altman plot was used to plot the mean difference between venous derived glucometer tested and laboratory blood glucose against the mean blood glucose level.

RESULTS:

Out of the total 20 patients, thirteen were males and seven females. The mean age was 47±5.7. The mean laboratory blood glucose was 127.47 mg/dl, and the mean capillary blood glucose was 138.01 mg/dl, giving a statistically significant difference (10.45 mg/dl, p=0.001) between the mean values for the laboratory and capillary glucose samples. The mean venous derived glucometer blood glucose was 143.96 mg/dl. There was a statistically significant difference (16.39 mg/dl, p=0.001) between the mean values for the laboratory and venous derived glucometer tested blood glucose. There was a 5.94 mg/dl difference between the capillary and venous derived glucometer tested samples. This was again statistically significant (p=0.05). Figure 1 shows a scatter graph detailing the correlation between laboratory and bedside capillary derived blood glucometer samples (r=0.97; p,0.001), and the Figure 2 shows the graph between laboratory and venous derived blood glucometer measurements (r=0.96; p,0.001).

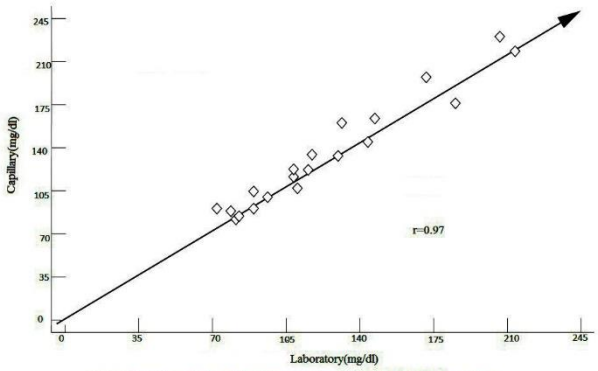

FIGURE 1: Correlation: laboratory and capillary blood glucose values

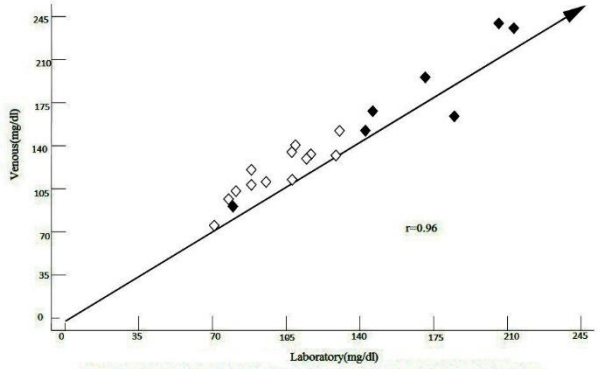

FIGURE 2: Correlation:laboratory and venous blood glucose values

Figure 3 shows a Bland and Altman plot demonstrating the differences in blood glucose between venous and laboratory blood glucose samples versus mean blood glucose levels. The mean difference shown is 18 mg/dl. This suggests that appreciable differences do occur between the venous glucometer and laboratory blood sugar levels despite a good correlation.

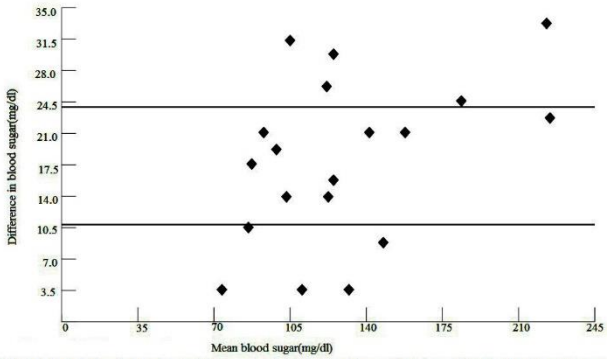

FIGURE 3: Bland and Altman plot: Venous and laboratory glucose. Mean and 95% CI of the difference.

DISCUSSION:

Glucose levels have to be assessed very frequently in hospital settings, and sending a blood sample each time for confirmation to the laboratory is a cumbersome, time taking procedure with additional discomfort and expense. Point of testing glucometers which were initially developed for glucose monitoring in adult patients with diabetes at home have now found their way into hospitals for use by doctors on sick patients because of the advantage of rapid turnaround time, reduced blood volume requirement, and clinical utility over traditional laboratory-based testing. Nevertheless, as shown in our research, their results do not exactly match the standard laboratory results. A similar conclusion was drawn by other studies as well, where discrepancies were found in the results of glucometers [3]. Critchel and Baig, in their studies, concluded that glucometers should be avoided in critically ill patients and intensive care settings [4,5]. In the current literature, there is no concluding evidence available as to whether capillary or venous blood glucose measurements tested on blood glucometers are more accurate. In a study done by Funk and Chan, on healthy volunteers, a weak correlation was found between capillary and venous blood glucose estimations using glucometers designed for capillary samples [6]. However, laboratory blood glucose testing was not done in that study to find out which one was more accurate. Gautam Kumar, in his study, concluded that capillary glucose values best approximated venous plasma glucose values from the laboratory. While venous blood glucose monitoring with glucometer resulted in an over-estimation of glucose compared with the laboratory results. This may result in the withholding of intravenous glucose for patients who are actually hypoglycemic [7].

In a study done by Funk et al., a weak correlation was obtained between the levels of venous and capillary blood glucose tested by glucometer [6]. In Boyd's study done on 20 bid ridden patients, a small but significant difference was obtained on comparing the venous blood glucose checked by glucometer and in the laboratory [8]. Kuwa et al., in their study, compared samples of capillary, venous, and plasma; the blood glucose levels in the three mentioned methods showed no significant difference [9]. In another study conducted by Dubose, the correlation between the levels of capillary and venous blood glucose was found in patients with and without shock, in which a slight difference was observed between both groups [10].

Although our study did show a statistically significant difference between the capillary and venous bedside blood glucose estimates, the difference (0.33 mmol/l) is minimal and may not be clinically significant in routine practice. The International Organization for Standardization Recommendations in 2003 proposed that for sample readings >75 mg/dl, the discrepancy between glucometers and accredited laboratory values should be <20%. For glucose readings ≤75 mg/dl, the discrepancy should not exceed 15 mg/dl in 95% of the samples [11,12].

Establishing the accuracy of glucometer is challenging. Glucometers use whole blood samples, but existing standards are based on serum samples. Since glucose is unstable in whole blood, it needs to be stabilized through glycolysis inhibitors, which this process can interfere with some glucometers [13]. Technical accuracy for glucometers should be tested by comparing glucometer results with clinical laboratory methods that use plasma/serum-based samples. All glucometers should be evaluated before use in critically ill patients, and the specific glucometer model selected should be based on technical and clinical performance in the selected patient population.

Our study had some limitations to it. The study sample was small, and the study was limited to non-critically ill patients. Only three patients had abnormal glucose values. Therefore, from this study, we cannot conclude the accuracy of glucometer values in critically ill patients, and in patients with blood glucose levels outside the normal range.

CONCLUSION:

A statistically significant yet small variation occurs in the blood glucose results analyzed by laboratory and glucometer. The clinical relevance of this variation may be non-significant, but caution must be exercised in accepting the glucometer results. It is therefore advisable that standard laboratory testing should be opted in protocols of tight glycemic control.

REFERENCES:

1. Dungan K, Chapman J, Braithwaite SS, Buse J. Glucose measurements: confounding issues in setting targets for inpatient management. Diabetes Care. 2007;30(2):403-409.
2. Heinemann L. Quality of glucose measurement with blood glucose meters at the point-of-care: relevance of interfering factors. Diabetes Technol Ther. 2010;12(11):847-857.
3. Topping J, Reardon M, Coleman J, Hunter B, Shojima-Perera H, Thyer L, Simpson P. A Comparison of Venous versus Capillary Blood Samples when Measuring Blood Glucose Using a Point-of-Care, Capillary-Based Glucometer. Prehosp Disaster Med. 2019;34(5):506-509.
4. Critchell, C.D., Savarese, V., Callahan, A. et al. Accuracy of bedside capillary blood glucose

measurements in critically ill patients. Intensive Care Med.2007;33:2079-2084.
5. Baig A, Siddiqui I, Jabbar A, Azam S, Sabir S, Alam S, Ghani F. Comparision between bed side testing of blood glucose by glucometer vs centralized testing in a tertiary care hospital. J Ayub Med Coll Abbottabad. 2007 ;19(3):25-9.
6. Funk Dl, Chan L, Lutz N, et al. Comparison of capillary and venous glucose measurements in healthy volunteers. Prehosp Emerg Care. 2001;5:275-7.
7. Kumar G, Sng L, Kumar S. Correlation of capillary and venous blood glucometry with laboratory determination. Prehospital Emergency Care.2004;8:378-383.
8. Boyd R, Leigh B, Stuart P. Capillary versus venous bedside blood glucose estimation. Emerg Med. 2005;22:177-9.
9. Kuwa K, Nakayama T, Hoshino T, Tominaga M. Relationships of glucose concentrations in capillary whole blood, venous whole blood and venous plasma. Clin Chim Acta. 2001;307:187–92.
10. Du Bose JJ, Inaba K, Branco BC, Barmparas G, Lam L, Teixeira PG, et al. Discrepancies between capillary glucose measurements and traditional laboratory assessments in both shock and non-shock states after trauma. J Surg Res. 2012;178:820–6.
11. Mahmoodpoor A, Hamishehkar H, Shadvar K, Sanaie S, Iranpour A, Fattahi V. Validity of bedside blood glucose measurement in critically ill patients with intensive insulin therapy. Indian J Crit Care Med. 2016;20(11):653–657.
12. Mahmoodpoor A, Sanaie S, Golzari SE. Slow deadoptation of a strategy: Was tight glycemic control truly impractical? Adv Biosci Clin Med. 2015;3:1–2.
13. Topping J, Reardon M, Coleman J, Hunter B, Shojima-Perera H, Thyer L, Simpson P. A Comparison of Venous versus Capillary Blood Samples when Measuring Blood Glucose Using a Point-of-Care, Capillary-Based Glucometer. Prehosp Disaster Med. 2019;34(5):506-509.