

<https://doi.org/10.48047/AFJBS.6.15.2024.3924-3929>

African Journal of Biological Sciences

Journal homepage: <http://www.afjbs.com>

Research Paper

Open Access

“Performance Evaluation for Blood Glucose Estimation from Capillary and Venous Sample by Point of Care Testing Device And Venous Sample by Fully Auto Analyzer In Normal and Diabetic Patient”- Cross Sectional Study

Dr. K. R. Gopalakrishnan¹, Dr. Hariom Sharma^{2*}, Dr. Darshna Jain³, Dr. D.Shreshtha⁴, Dr Shreyansh Sharma⁵
Dr. Piyush Tailor⁶

¹PG Resident, Department of Biochemistry, GMC, Bhavnagar, Gujarat, India

²Professor, Department of Biochemistry, GMC, Bhavnagar, Gujarat, India

³Associate Professor, Department of Biochemistry, GMC Ratlam, MP, India

⁴Medical officer, Central Health Services, RHTC- Najafgarh, New Delhi, India

⁵Tutor, Department of Biochemistry, Narendra modi Medical college, Ahmedabad ,Gujarat,India

⁶Professor & HOD of Biochemistry, GMC, Bhavnagar, Gujarat, India

Corresponding author- **Dr. Hariom Sharma***

Article History

Volume 6, Issue 15, 2024

Received : 03 May 2024

Accepted : 28 Aug 2024

Published: 07 Sep 2024

[doi:10.48047/AFJBS.6.15.2024.3924-3929](https://doi.org/10.48047/AFJBS.6.15.2024.3924-3929)

Abstract: *Introduction:* Diabetes Mellitus (DM) is the most common metabolic disorder in nearly 5-10% of western population aged more than 40 years. Blood glucose estimation is the main stay of diagnosis and management of DM. *Aim:* Compare the blood glucose estimation methods from capillary blood and venous blood by glucometer and also with venous plasma glucose estimation by auto analyzer and to find out variation percentages in results. *Material & Methods:* 196 patients attending Outpatient department of a tertiary care level hospital who were advised blood glucose estimation were selected. Finger prick (capillary) blood glucose & venous blood glucose estimation was done by glucometer; and plasma glucose estimation was done by auto analyzer in laboratory. *Result:* Average blood glucose value in all 196 subjects shown as (C), (V) & (P), 169.54 mg/dl, 184.11 mg/dl & 155.93 mg/dl respectively, suggests highest value in venous sample (V) and lowest in Plasma sample (P). The difference between venous sample & capillary sample is =14.574 mg/dl, Venous sample & plasma sample is = 28.185 mg/dl and capillary sample & plasma sample is = 13.610 mg/dl. Range of differences between different methods is between 13.610 to 28.185 mg/dl. Highest values are in and lowest in 28.185 mg/dl & 13.610 mg/dl, respectively. The percentage variation value (X), (Y) & (Z) are 91.33%, 19.90%, & 90.31% of subjects, respectively, are showing less than 15% variation difference in blood glucose value. *Conclusion:* Capillary blood glucose estimation by glucometer is a better alternative to venous plasma glucose estimation for diagnosis; follow up and in emergency conditions in diabetic as well as non-diabetic patients. Venous blood glucose estimation by glucometer is not advisable as a routine method, but it is advisable when patient refuses for a second pin prick of finger.

Keywords: Glucometer, capillary, venous, blood glucose, glucosetestrip

1. INTRODUCTION

One in eleven Indians, or around 77 million people, have a formal diagnosis of diabetes. In India, 700,000 people passed away in 2020 from diabetes-related renal disease, hyperglycaemia, or other consequences. The International Diabetes Federation predicts that by 2045, there will be 134 million people worldwide with diabetes. Its incidence has been steadily rising over the last few decades, especially in developing nations like India. Nearly 5–10% of Westerners over the age of 40 have diabetes mellitus, the most prevalent metabolic condition. Since the previous few decades, its incidence in developing nations like India has been rising quickly. By 2020, India would have the highest prevalence of diabetes mellitus. Averting diabetes mellitus or having impaired glucose tolerance can happen to one in four people over the age of 40. Only venous plasma samples can be used to diagnose diabetes mellitus (DM) and impaired glucose tolerance, according to WHO guidelines. The mainstay of DM diagnosis and management is by blood glucose measurement. Additionally, it is advised to monitor blood sugar on an hourly basis to treat diabetic ketoacidosis, hyperosmolar condition, and hypoglycaemia. In these circumstances, glucometer monitoring is more practical, affordable and more expedient than lab analysis. Therefore, it is crucial to compare and uncover discrepancies in blood collection and estimation methods' outcomes. When estimated from whole blood and plasma venous blood, or capillary blood, the glucose level varies noticeably. Additionally, it changes with the use of the glucometer and the auto analyzer. In our study, we attempted to compare the outcomes of blood glucose estimate using a glucometer for capillary whole blood, a glucometer for venous whole blood, and an auto analyzer for plasma glucose. Whether a patient had diabetes or not was irrelevant when estimating their blood glucose level. While postprandial venous blood glucose levels are 7% lower than postprandial capillaries blood glucose levels due to glucose absorption by tissue cells via diffusion in peripheral capillaries and some residual glucose returning to veins, there are some differences between fasting capillaries glucose and fasting venous glucose.

2. AIM

- To compare the blood glucose estimation from capillary blood and venous blood by point of care testing and also with plasma glucose estimation by auto analyzer in normal and Diabetic patient
- Percentage variation between different method of estimation glucose.
- To evaluate difference between fasting and postprandial venous sample.
- To evaluate Age wise distribution of venous sample.

3. Materials and Methods

Prior permission will be taken from Ethical committee, Government Medical College, Bhavnagar. Participants will be enrolled in the study after meeting the inclusion, exclusion criteria and after taking written informed consent. Blood sugar, will be measured by using standard protocol.

3.1 Glucometer Procedure

Insert a test strip into glucometer. Prick the middle or ring finger tip with needle (lancet) provided with test kit. Touch and hold the edge of the test strip to the drop of blood (0.5 ml). The meter will display your blood sugar level on screen after a few seconds.

3.2 Procedure for venous sample through glucometer

Clean the area with an antiseptic, like alcohol, to kill any germs. Tie an elastic band around your upper arm, causing your veins to swell with blood. Then insert a sterile needle into a vein and collect 2 ml of venous sample in a sterile syringe. Dropping drop of blood from syringe over the Sterile glass slide. Touch and hold the edge of the test strip to the drop of blood (0.5 ml). The meter will display your blood sugar level on screen after a few seconds.

3.3 Fully auto-analyzer

2 ml of venous plasma sample was collected in fluoride containing collecting tube through a needle syringe. The venous sample was then centrifuged at 4000 rpm for about 4 minutes in order to separate the plasma. The plasma obtained was used to estimate the glucose concentration by hexokinase method using c8000 abbott auto analyzer. A lab identification number will be given to each sample. Patient identity will be encoded by entering Lab ID number, registration number and Result. Data analysis will be done by using appropriate statistical test using Microsoft excel and graph pad in stat 3.0

The study's participants were all people, ages 18 to 70, who visited an outpatient department (OPD) of a tertiary care hospital and were instructed by their consultant to have their blood glucose levels estimated. All subjects had their blood sugar tested, regardless of whether they had diabetes or not. Antecubital vein of the subject was used to collect venous blood samples after obtaining informed consent and registration. The acquired sample was transmitted to the central laboratory's auto analyzer for determination of plasma glucose. The remaining whole blood in the syringe was utilized to estimate blood sugar using a glucometer. The same glucometer was used to estimate blood glucose levels from capillary samples simultaneously. A master chart was created that contained all three results. The various blood sample

types and estimate techniques are displayed in Table 1.

Table 1: Blood samples type & Methods of estimation

Blood Sample types	Blood Sample types Method of blood
Capillary whole blood Glucose (c)	TRUE result blood glucosetest* and glucometer
Venous whole blood Glucose (v)	TRUE result blood glucosetest* and glucometer
Venous plasma Glucose (p)	Hexokinase Method by Auto analyzer

Note: "TRUE result test strip" measures whole blood glucose by glucose dehydrogenase-FAD reaction, in which glucose in the sample reacts with the chemicals and produces an electric current. The meter measures the current and calculates the amount of glucose. The meter measures the current and calculates the amount of glucose. GOD-POD method: - Trinder's methodology (D glucose is converted to red dye by enzymatic reaction with use of glucose) GOD-POD reagent auto-analyzer system is used to estimate plasma glucose of venous sample in central laboratory.

RESULTS

All 60 subjects were classified into **Group A, B C** and as per their plasma glucose levels done by auto analyser as shown in the above table. Plasma glucose (P), less than or equivalent to 100mg/dl is **Group A**, between 101 - 200mg/dl is **Group B** & more than 200mg/dl is **Group C**.

Table 2: Distribution of study subjects according to blood glucose level

Established status of diabetes mellitus	Blood glucose ≤ 100 mg/dl Group A	Blood glucose 101-200 mg/dl Group B	Blood glucose > 200mg/dl Group C	Total	Percentage (%)
DM	0	57	39	98	48.98
Non-DM	37	63	0	100	51.02
Total	37	122	39	198	100

In the above Table 2, In Diabetic Mellitus, 57 patients under 101-200mg/dl, 39 patient >200mg/dl its percentage 48.98 and in Non Diabetic Mellitus, 37 patients under <100mg/dl, 63 patients under 101-200mg/dl its percentage 51.02%.

Table 3: Average Blood glucose level and standard deviation in Groups A, B and C

Groups	Average standard deviation	Capillary blood glucose (C) mg/dl (Glucometer)	Venous blood glucose (V) mg/dl (Glucometer)	Auto Analyzer plasma(P) mg/dl
Total blood glucose level mg/dl	Mean ± 1 SD	169.54± 75.80	184.11± 78.22	155.93± 73.45
less than or 100 mg/dl Group A	Mean ± 1 SD	90.13± 7.46	92.2± 9.31	85.43± 8.89
101-200 mg/dl Group B	Mean ± 1 SD	144.5± 24.24	150.16± 27.44	139.09± 25.82
More than 200 Group C	Mean ± 1 SD	292.82± 69.21	294.18± 69.92	288.25± 71.66

In the above Table 3, average blood glucose value in all 196 subjects shown as (C), (V) & (P), 169.54 mg/dl, 184.11 mg/dl & 155.93 mg/dl respectively, suggests highest value in venous sample (V) and lowest in Plasma sample (P). The average and standard deviation of blood glucose levels in all the three groups suggest highest values in venous sample (V) and lowest in capillary sample (C). It is interesting to note that the level increases in the groups from A to B to C, as blood glucose level increases. Venous blood glucose (V) estimation by glucometer has a higher total and mean value than capillary blood glucose (C) and it is the lowest in plasma glucose value (P).

Table 4: Difference in Blood glucose level by different methods

Difference in blood glucose level mg/dl	(X) mg/dl	(Y) mg/dl	(Z) mg/dl
Total	14.574	28.185	13.610
Group A	2.070	6.768	4.698
Group B	5.660	11.064	5.404
Group C	1.359	5.930	4.571

Note: (X) = V - C VALUE, (Y) = V - P VALUE, (Z) = C - P VALUE.

Table 4 shows that the difference between venous sample & capillary sample is =14.574 mg/dl, Venous sample & plasma sample is = 28.185 mg/dl and capillary sample & plasma sample is = 13.610 mg/dl. Range of differences between different methods is between 13.610 to 28.185 mg/dl. Highest values are in and lowest in 28.185 mg/dl & 13.610 mg/dl, respectively. The different blood glucose level values (X), (Y) & (Z) shown in each group A, B, & C do not show any specific correlation.

Table 5: The variation percentage seen according to different method

Variation %	(X) mg/dl (C-V)	(Y) mg/dl (P-V)	(Z) mg/dl (C-P)
<5%	31	5	16
5-10%	86	6	94
10-15%	62	28	67
Subject no. up to 15%/Total (%)	179/196	39/196	177/196
15%	91.33%	19.90%	90.31%

Table 5 the variation percentage shown in above suggests less than 15 % variation in value, in nearly 90.31% cases between capillary (C) versus plasma (P) samples, 19.90% cases in plasma (P) versus venous (V), while 91.33% in Capillary (C) versus venous (V) samples. All calculations were done with standard statistical computerized methods. In short, all the above results show following:

1. As blood glucose level rises in Group A, B & C; mean glucose level and standard deviation also rise
2. The difference value trend in all groups doesn't follow any increasing or decreasing pattern.
3. The percentage variation value (X), (Y) & (Z) are compared. 91.33%, 19.90%, & 90.31% of subjects, respectively, are showing less than 15% variation difference in blood glucose value.

Table 6: Distribution of study subjects according to Fasting and Post Prandial Sample

Blood samples	Blood glucose ≤100 mg/dl Group A	Blood glucose 101-200 Group B	Blood glucose >200 Group C	Total	Percentage (%)
Fasting	37	57	6	100	51.02
Postprandial	0	63	33	96	48.98
	37	120	39	196	100

Table 6 shows Fasting and Post Prandial Blood glucose level. Total number of 100 fasting sample taken and 96 Post Prandial Blood glucose sample taken. 51% of fasting sample and 48.97% of post prandial sample.

Table 7: Distribution of study subjects according to age criteria

Age	Blood glucose ≤100 mg/dl Group A	Blood glucose 101-200 Group B	Blood glucose >200 Group C	Total
18-27	9	0	0	9
28-37	6	17	5	28
38-47	10	31	8	49
48-57	5	25	11	41
58-67	6	32	12	50
68-75	2	15	2	19
				196

Table 7 shows age wise distribution of blood sugar level, it shows from age group 18-27 total sample received 9, from 28-37 total sample received 28, from 38-47 total sample received 49, from 48-57 total sample received 41, from 58-67 total sample received 50, from 68-75 total sample received 19. Most number of samples received from age group of 38 to 67 age group.

DISCUSSION

Blood glucose concentration estimation is based on three types of samplings. 1. Venous blood sampling estimated by laboratory autoanalyzer method. 2. Capillary blood glucose estimated by glucometer and 3. Venous sample estimated by glucometer. In this study, finger prick capillary mean blood glucose by glucometer is higher than plasma glucose estimation by Fully autoanalyzer done in laboratory method by 9.63 mg/dL and variation percentage less than 15% between two samples is in 90% subjects. It suggests that capillary blood glucose estimation may not be as reproducible as plasma glucose estimation. As blood glucose level difference percentage rises with increase in value in glucose level, in more than 200mg/dl group, it leads to less accurate correlation at higher than 200mg/dl level. But even

at higher level, 15% or less variation percentage was noted in 60 % subjects. So, utilization of finger prick method with glucometer estimation is a better alternative in cases with glucose levels up to 200mg/dl or less level of blood glucose and an acceptable alternative to venous blood glucose estimation above 200mg/dl glucose levels. Similar observations were noted in other studies also. The level of capillary blood glucose is comparable to arterial blood glucose level while venous plasma glucose level is the estimate glucose after utilization of glucose by tissues. The remaining amount returns to the venous side. So, on lower side, change in concentration depends on tissue extraction of glucose. It is also depending on effects of insulin, glucagon, growth hormone and cortisone and also on demand of tissues and postprandial and fasting status as well as the level of blood glucose. The variation percentage increases as blood glucose level increases. The percentage change is explained by all these factors, but change is insignificant in clinical practice as blood glucose for diagnostic as well as monitoring criteria is well under 200 mg/dl, i.e., Fasting Blood glucose is 126 mg/dL, while post- prandial blood glucose is 200mg/dl or more in the WHO recommendations for the diagnosis of diabetes mellitus. The disadvantages of venous blood glucose estimation are many. 1. More painful than finger prick, 2. Expert phlebotomist required. 3. More punctures. 4. Counter puncture of vein and hematoma. 5. Long time consumed in laboratory process, nearly 3 hours. Finger prick estimation on the contrary has all the advantage 1. Spot result 2. Convenience and also acceptability for patient. 3. No loss of precious time in emergency management. Results of venous plasma glucose estimation by laboratory analyzer and venous whole blood analyzed by glucometer method showed marked variation in blood glucose levels with no definite pattern in the variation of results. Also to be noted, only 19.90% samples had less than 15% variation, because glucometer is calibrated for estimation of pinprick capillary blood glucose which shows digitalized display and it is equivalent to plasma glucose estimation. So venous blood or blood from other part of body may give irrelevant & wide variations by glucometer, when compared with venous plasma glucose. So, in clinical practice, it is a significant variation in value of blood glucose from venous blood glucose estimated by glucometer. Hence, using present glucometer for venous blood glucose estimation is not recommended. The same time estimation of capillary blood glucose from pinprick and venous blood glucose estimated by glucometer shows less than 15% variation in readings in 91.33%. This suggests a good correlation in levels. So, ante cubital vein sample can be significantly matched with the pinprick capillary samples, but results do not correspond with plasma glucose as the variation becomes wider and without any specific trend. This method is not recommended, except when the patient refuses for a second prick of finger pulp. Limitation of study: As the study includes 196 subjects only, a larger study is necessary for authentication of the findings. Although, larger studies also show same evaluation results. There is a marked variation in glucose level, when estimated from plasma, venous blood or capillary blood. It also varies with glucometer method and Auto analyzer method. In our study, we have tried to compare the results of blood glucose estimation in capillary and venous whole blood by glucometer and plasma glucose estimation by Auto analyzer.

Estimation of blood glucose done in all patients irrespective of their diabetic or non-diabetic status.

The American Diabetes Association (ADA) has recommended that glucometers agree to within +15% of the laboratory method at all concentrations, with a future performance goal of +5% agreement at glucose concentration.

CONCLUSION

Capillary blood glucose estimation by glucometer is a better alternative to venous plasma glucose estimation for diagnosis; follow up and in emergency conditions in diabetic and non-diabetic patients. Venous blood glucose estimation by glucometer is not advisable as a routine method, but it is advocated when patient refuses for a second pin prick of finger pulp.

REFERENCE

- Longo, C., Fauci, H., & Jameson, L. (2011). Harrison principles of Medicine. Diabetes Mellitus. 18th ed. McGraw Hill, (2), 2969-2970.
- Longo, C., Fauci, H., & Jameson, L. (2011). Harrison principles of Medicine. Diabetes Mellitus. 18th ed. McGraw Hill, (2), 2970-1971.
- Risaiah, B. (1985). Self monitoring of blood glucose level: potential sources of inaccuracy. *Can Med Assoc J*, 132(12), 1357-1361. PMID: PMC1346098.
- American Diabetes Association. (2006). Standard of Medical Care in Diabetes, 29(suppl 1), s4-s42.
- International Organisation for standardization. (2013). In vitro diagnostic test systems. Requirement for blood-glucose monitoring system for self-testing in managing diabetes mellitus. Reference no ISO 15197: 2013 (E). Geneva: International organisation for standardization.
- Baig, A., Siddiqui, I., Jabbar, A., Azam, S. I., Sabir, S., Alam, S., & Ghani, F. (2007). Comparison between bed side testing of blood glucose by glucometer vs centralized testing in a tertiary care hospital. *Journal of Ayub Medical College Abbottabad*, 19(3), 25-29. Available form: <http://www.ncbi.nih.gov/pubmed/18444586>.
- Colagiuri, S., Sandbaek, A., Carstensen, B., Christensen, J., Glumer, C., Lauritzen, T., & Borch-Johnsen, K. (2003). Comparability of venous and capillary glucose measurements in blood. *Diabetic medicine*, 20(11), 953-956. Available form: <http://www.ncbi.nih.gov/pubmed/14632723>

- Glucose, M. (2009). A Review of Technical Challenges to Obtaining Accurate Results. *Journal Diabetes Science and Technology: From basic Science to Clinical Practice*, 3(4), 971-980.