



ISSN: 0976-3031

Available Online at <http://www.recentscientific.com>

CODEN: IJRSFP (USA)

International Journal of Recent Scientific Research
Vol. 10, Issue, 06(J), pp. 33225-33227, June, 2019

**International Journal of
Recent Scientific
Research**

DOI: 10.24327/IJRSR

Research Article

BLOOD GLUCOSE TESTING: A COMPARATIVE ANALYSIS OF SPECTROPHOTOMETER AND GLUCOMETER IN HOSPITAL BASED MEDICAL LABORATORY IN JOS-NIGERIA

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DOI: <http://dx.doi.org/10.24327/ijrsr.2019.1006.3633>

ARTICLE INFO

Article History:

Received 13th March, 2019

Received in revised form 11th

April, 2019

Accepted 8th May, 2019

Published online 28th June, 2019

Key Words:

Blood glucose, spectrophotometer,
glucometer, hospital medical laboratory.

ABSTRACT

Background: Diabetes mellitus poses a serious health challenge worldwide and there has been an increased awareness for self-monitoring and point of care testing. There are different methods to determine blood glucose levels and glucometers have been of help to improve turn-around time. Comparison of glucose result by spectrophotometer method and glucometer was done in this study. **Materials and Methods:** 200 subjects male and female ages 20 and above were tested using methods involving glucometer and spectrophotometer. **Result:** 185(92.5%) has glucose level (random blood sugar) within normal range, 15(7.5%) above normal range by spectrophotometer while 180 (90.0%) showed glucose level within normal range and 20(10.0%) above normal range by glucometer using Normal range as 3.5-11.0mMol/L. Statistical comparison of blood glucose result by the two methods using students't-test showed significant difference (P<0.05). Correlation analysis of the two methods shows strong correlation which is significant at P<0.01. **Conclusion:** The study established the fact that there is a significant difference between blood glucose result obtained from spectrometric method and glucometer but there is a strong correlation in glucose estimation.

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INTRODUCTION

Total preventative treatment or cure for diabetes is not yet achieved or developed currently, however the management of the life-impeding conditions of the disease is currently the most successful means through monitoring glucose levels in blood, which has proven to prolong life and enable diabetic patients to be managed for hypo- or hyperglycaemia (Danielle *et al*, 2017; Zhanxiao *et al*, 2017). Some methods of estimation of glucose depend on the reducing properties of sugar which are not specific for glucose and such estimations are expressed as blood sugar estimations. In some cases, the non- glucose reducing substances are removed as part of glucose determination and the resulting value is known as true glucose values. The method like the Glucose Oxidase method, confers high degree of specificity on the measurement of glucose in blood and urine (Ochei and Kolhaktar, 2000). In the 21st century, Glucose became the most tested parameter and there came a number of different electrochemical glucose meter systems, including the OneTouch, and many more (Clarke & Foster, 2012). Though Glucometer is widely used in hospitals and homes as a first line tool to get an idea about the current blood glucose levels. This has made glucometers to be used for

making important decisions in so many health facilities about glucose concentration but it is essential that their accuracy should be comparable to those of standard medical laboratory blood glucose analyzers. Glucometers present an important self-monitoring tool for diabetes patients however, the users must ensure that the machines exhibit high accuracy as well as good usability features (Nevine & Abdelhak, 2016). Colorimetric/spectrophotometric estimation of plasma glucose using glucose oxidase peroxidase method has been shown to be gold standard for glucose estimation as enzymatic method is very specific for glucose though may not be suitable for emergency cases due to turn around time. (Sherie *et al.*, 2017, Sergio *et al.*, 2009)

Falah (2016) referred to use of glucose meters for home monitoring to be associated with decreased morbidity and mortality related to diabetes especially in type 2 diabetes patients though Lippi and colleagues (2006) recommended that all insulin-treated patients should be basically the ones to perform self-monitoring of blood glucose to prevent and detect severe hypoglycemia associated with over treatment or some changes in lifestyle and to establish the need for insulin

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therapy in patients with insulin dependent diabetes mellitus or gestational diabetes.

In most medical laboratories, plasma or serum is used for most glucose determination while method for self-monitoring of glucose use concentration in plasma phase (Carl et al., 2008) and this calls for urgent attention in clinical decisions surrounding the various glucose test results especially with ones performed by glucose meters and glucose strips. This study is aimed to compare blood glucose results with spectrophotometer and glucometer in a bid to assess the use of glucometer as a point of care testing (POCT) equipment in various hospital medical laboratories.

MATERIA AND METHODS

Ethical clearance was obtained from the ethical committee of the 3RD Division Military Hospital. Jos. The patients and clients that came to the general outpatient department (GOPD) were given a brief talk on the significance of blood glucose testing and those willing to participate were served with an informed consent form for participation in the study.

A total of 200 subjects, made up of both males (120) and females (80) with ages ranging from 20 to 70 years were recruited for the research. 3.0ml of blood was collected by venipuncture into sodium fluoride containers and a drop of whole blood was used for glucose determination by glucometer concurrently. The sample in fluoride containers were processed as described by Ochei and Kolhaktar (2000) for spectrophotometer use in determination of random blood glucose (RBG) within 1-6 hours.

Principle of Glucose Oxidase used for the spectrophotometer Glucose is determined after enzymatic oxidation in the presence of glucose oxidase. The hydrogen peroxide formed reacts, under catalysis of peroxides, with phenol and 4 aminophenazone to form a red-violet quinonimine dye as indicator.

Test principle for One Touch states that Glucose in the blood sample mixes with special chemicals in the test strip and a small electric current is produced. The strength of this current changes with the amount of glucose in the blood sample. The meter measures the current, calculates your blood glucose level, displays the result, and stores it in its memory.

The procedure described by One Touch® Ultra® 2 Blood Glucose Monitoring System Manual of 2014 was adequately followed in the glucose measurement. Percentages, descriptive statistics, students’ t-test and Pearson Correlation were used to analyze the result.

RESULT

Table 1 Distribution of subjects tested according to age groups with respective mean values and standard deviation for spectrophotometer and glucometer

Age groups (Yrs)	No Tested (%)	Mean Value + SD Spectrophotometer. (mMol/L)	Mean Val. + SD Glucometer (mMol/L)
20-29	68(34.0)	3.87±1.30	6.09± 1.64
30-39	38(19.0)	5.86±4.41	7.68±5.45
40-49	55(27.5)	5.86±2.44	7.85±2.23
50-59	15(7.5)	9.51± 5.46	11.82±5.97
>60	24(12.0)	4.99±0.83	6.62±1.09
Total/Average	200(100)	5.56±3.26	7.49±3.57

Table 2 Distribution according to glucose value range

	Spectrophotometer	Glucometer
No. tested with normal Glucose range	185(92.5)	180(90.0)
No. tested with Glucose Range above normal	15(7.5)	20(10.0)
Total	200(100.0)	200(100.0)

15 subjects showed elevated glucose value above normal range by spectrophotometer while 20 showed elevated value above normal range by glucometer using the reference range of random blood sugar as 3.5-11.0 mMol/L.

Table 3 Correlation between spectrophotometer and glucometer Correlations

		Spectrophotometer Value	Glucometer Value
Spectrophotometer Value	Pearson Correlation	1	.936(**)
	P-Value		0.05
	N	200	200
Glucometer value	Pearson Correlation	.963(**)	1
	P-Value	0.05	
	N	200	200

** Correlation is significant at the 0.01 level (2-tailed)

The statistical analysis shows a strong correlation between the two methods. Correlation significant at 0.01.

Table 5 Paired Samples Test

Pair	Mean	Std Deviation	Std Error Mean	Paired Difference 95% Confidence Interval of the Difference		t	Df	P-Value
				Lower	Upper			
Pair Spectrophotometer Value - Glucometer Value	1.927	.9861	.0697	-2.064	-1.789	-27.629	199	0.05

Paired test between Spectrophotometer Value - Glucometer Value shows significance P<0.05

DISCUSSION

In all 200 subjects, 15 subjects showed elevated glucose value above normal range by spectrophotometer while 20 showed elevated value above normal range by glucometer using the reference range of random blood sugar as 3.5-11.0 mMol/L. Comparison of glucose result using spectrophotometer and glucometer using the students’ t-test was significant (p<0.05). The statistical analysis shows a strong correlation between the two methods with the correlation significant at 0.01.

This study agrees with Sergio and coworkers(2009) who raised alarm that glucometer method over estimates blood levels that could expose patients to more frequent and prolonged hypoglycemic events. This study equally agrees with Lippi and colleagues (2006) that glucometer should only be used for self-monitoring of blood glucose to prevent and detect severe hypoglycemia associated as usage in a clinical certain may be detrimental to patients. Use of Glucometer as a point of care testing machine for glucose is discouraged by this study. This is because of the fact that most points of the care areas exists in

hospitals where there are medical laboratories. Though for emergency situations, Glucometer can be used on the interim while waiting for a confirmatory result from a standardized medical laboratory using other better equipment like spectrophotometer for the glucose testing.

From this definition the glucometer method can be said to have a 100% clinical sensitivity because it could pick correctly all those with disease condition (hyper or hypoglycaemia). But it is not so clinically specific because it could label some individuals with normoglycaemic status as hyperglycaemic.

CONCLUSION

This study reveals that there is a significant difference between blood glucose result measured Spectrophotometer which can also be referred to as Reference Method (RM) and that by Glucometer referred to as point of care testing (POCT) or field method (FM). There is strong correlation between the two methods which means the glucometer produces valid results and can be used for monitoring purposes but should not be for diagnostic conclusion on blood glucose testing in medical laboratories, clinics and wards. This is because some medical laboratories, clinics and wards have abused the use of glucometer.

The One Touch® Ultra® 2 Blood Glucose Monitoring System Manual of 2014 said it all when it described the intended use “for the quantitative measurement of glucose (sugar) in fresh capillary whole blood. The One Touch® Ultra® 2 System is intended for use outside the body (in vitro diagnostic use) by people with diabetes at home and by health care professionals in a clinical setting as an aid to monitor the effectiveness of diabetes control. It should not be used for the diagnosis of diabetes or for testing newborns”.

Recommendations

In view of the Findings in this study, it is Recommended that

1. As much as it is easy and convenient to use glucometer, it results should be cross checked with standard medical laboratory equipment such as spectrophotometer and other advanced methods.
2. Physicians and other Health workers should be aware that glucometers are not 100% clinically specific; they can give especially false positive results and vice versa.
3. Patients should not use the glucometer results to modify their drug without a confirmed glucose result from a standard certified hospital medical laboratory.

How to cite this article:

Olaniru OB *et al.*, 2019, Blood Glucose Testing: A Comparative Analysis of Spectrophotometer and Glucometer in Hospital Based Medical Laboratory in Jos-Nigeria. *Int J Recent Sci Res.* 10(06), pp. 33225-33227.
DOI: <http://dx.doi.org/10.24327/ijrsr.2019.1006.3633>

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