

# Research Journal of Pharmaceutical, Biological and Chemical Sciences

## Diagnostic Accuracy Of Hemoglobin Estimation By Point Of Care Devices: A Comparative Study With The Automated Hematology Analyzer.

R Akila\*.

Assistant Professor Department Of Pathology, Thanjavur Medical College, Thanjavur. 613004, Tamil Nadu, India.

### ABSTRACT

Hemoglobin (Hb) estimation for the assessment of anemia can be done by various methods. Each of these methods has their own advantages and limitations. The present study was conducted to assess the accuracy of the commonly used point of care devices – HemoCue 301 and Handyspan, a portable hemocalorimeter to assess haemoglobin against the automated hematology analyzer Coulter 780. Hb was assessed in fifty blood samples by utilizing the HemoCue, Handyspan and Automated hematology analyzer Coulter 780. The results by HemoCue and Handyspan devices were comparable with that obtained by the automated hematology analyzer Coulter 780. Hence it was derived that the Point of care devices such as HemoCue and portable hemocalorimetry (Handyspan) are as accurate as the Automated hematology analyzer Coulter 780.

**Keywords:** Hemoglobin, Cyanmethemoglobin, Automated methods, HemoCue, Handyspan, Point of care devices (POCD).

<https://doi.org/10.33887/rjpbcs/2023.14.5.41>

*\*Corresponding author*

## INTRODUCTION

Hemoglobin estimation is the most frequent laboratory investigation requested in clinical practice. Different methods are used to estimate the hemoglobin in the blood.

Besides the use of traditional laboratory resources, the diagnosis of anemia can also be accomplished by assessing hemoglobin (Hb) concentration with Point-of-care testing (POCT) devices such as the HemoCue, portable hemocalorimetry (Handyspan) test systems. In several situations, these devices might suitably replace traditional laboratory testing, including several areas of health care where a very rapid hemoglobin measurement might be required to make immediate therapeutic decisions. For instance, it could be imperative in patients who require critical venous access, especially neonates and those undergoing chemotherapy due to the low amount of blood required by these devices, as well as in natural disasters or in sports medicine [1-5].

### Aims And Objectives

The aims and objectives of the current study are to

- Compare the hemoglobin values obtained by automated hematology analyzer Coulter 780 with the point of care devices (POCD) such as Hemocue and portable hemocalorimetry (Handyspan) and to evaluate the diagnostic accuracy of these Point of care devices.

## MATERIALS AND METHODS

Hemoglobin was estimated from the venous and capillary blood samples collected from fifty adults using Hemocue, Handyspan and Automated hematology analyzer Coulter 780 method. This study was conducted at Department of pathology in collaboration with Department of General medicine, Thanjavur medical college, Thanjavur during the period -April 2021 to December 2021.

### Hemocuehb 301 Method

The fingertip is pricked with a sterile lance after cleaning the finger with 70% alcohol. Wipeaway first 2-3 drops of blood. Fill the microcuvette in one continuous process with 10 microlitres of blood. Place the filled cuvette in the cuvette holder. After 10 seconds the hemoglobin measurement is made. This is a photoelectric method based on the determination of azide methemoglobin.



**Figure 1: Hemocue HB 301**

### Handyspan Method

The hemoglobin level is estimated using alkali-haematin method. The blood is diluted using an alkaline solution containing a non-ionic detergent at pH 13.0. This converts all hemoglobin derivatives into

a stable end product, alkali-hematin. The absorbance maxima of alkali-hematin is at 575nm. Absorbance of alkali hematin is directly proportional to hemoglobin concentration in blood.

$$\text{Hemoglobin concentration (gm/dl)} = \frac{\text{Absorbance of test}}{\text{Absorbance of standard}} \times \text{Concentration of standard}$$



**Figure 2 : Handyspan**

#### **Automated Hematology Analyzer Coulter 780**

The lytic reagent rapidly and simultaneously destroys the erythrocytes and converts a substantial proportion of the hemoglobin to a stable pigment. The absorbance of the pigment is directly proportional to the hemoglobin concentration of the sample. The accuracy of this method equals that of the hemoglobin cyanide method, the reference method of choice hemoglobinometry recommended by the international committee for standardization in hematology.



**Figure 3: Coulter 780**

The results obtained by the three methods were compared using appropriate statistical methods.

**RESULTS**

**Frequency Table**

**Age**

Particulars	No.of respondents	Percentage
21 to 30yrs	9	18.0
31 to 40yrs	5	10.0
41 to 50yrs	12	24.0
51 to 60yrs	15	30.0
61 to 70yrs	9	18.0
<b>Total</b>	<b>50</b>	<b>100.0</b>

One third (30 per cent) of the respondents were in 51 to 60yrs of age group.

**Sex**

Particulars	No.of respondents	Percentage
Male	33	66.0
Female	17	34.0
Total	50	100.0

Majority (66 per cent) of the respondents were male.

**Oneway ANOVA difference between age of the respondents and their method of Auto, Hemocue and HandySpan**

Age	n	Mean	S.D	SS	Df	MS	Statistical inference
<b>Auto</b>							
Between Groups				80.102	4	20.026	F=2.593 .049>0.05 Not Significant
21 to 30yrs	9	12.6778	2.23594				
31 to 40yrs	5	14.7800	.95760				
41 to 50yrs	12	11.5250	2.86773				
51 to 60yrs	15	10.6733	2.97453				
61 to 70yrs	9	12.9667	3.34664				
Within Groups				347.595	45	7.724	
<b>Hemocue</b>							
Between Groups				88.477	4	22.119	F=2.887 .033<0.05 Significant
21 to 30yrs	9	13.3444	2.23725				
31 to 40yrs	5	15.3600	1.04547				
41 to 50yrs	12	12.1500	2.83148				
51 to 60yrs	15	11.1200	2.99647				
61 to 70yrs	9	13.6667	3.28748				
Within Groups				344.768	45	7.662	
<b>Span</b>							
Between Groups				63.072	4	15.768	F=1.956 .118>0.05 Not Significant
21 to 30yrs	9	12.0889	2.29970				
31 to 40yrs	5	14.5400	1.07378				
41 to 50yrs	12	11.7750	2.88164				
51 to 60yrs	15	10.8267	2.74447				
61 to 70yrs	9	13.0333	3.85681				
Within Groups				362.713	45	8.060	

Statistical test: Oneway ANOVA 'f' test was used the above table

The above table auto methods of mean  $\pm$  S.D values from 21 to 30yrs age group (n=9) 12.6778  $\pm$  2.23594, 31 to 40yrs age group (n=5) 14.7800  $\pm$  0.95760, 41 to 50yrs age group (n=12) 11.52.50  $\pm$  2.86773, 51 to 60yrs age group (n=15) 10.6733  $\pm$  2.97453 and remaining 61 to 70yrs age group (n=9) 12.9667  $\pm$

3.34664. Therefore, there is no significant difference between age of the respondents and their auto methods. Hence, the calculated value greater than table value (0.049>0.05)

**T-Test**

	n	Mean	S.D	Statistical inference
<b>Auto</b>				
Male	33	13.1091	2.78336	t=3.987 df=48 0.000<0.05 Significant
Female	17	10.0294	2.14148	
<b>Hemocue</b>				
Male	33	13.7061	2.79586	t=3.998 df=48 0.000<0.05 Significant
Female	17	10.6000	2.16304	
<b>Span</b>				
Male	33	13.0939	2.77409	t=3.983 df=48 0.000<0.05 Significant
Female	17	10.0235	2.14695	

**Paired Sample 't' test**

	n	Mean	S.D	Correlation	Statistical inference	Mean	S.D	t	df	Statistical inference
Auto	50	12.0620	2.95441	.997	0.000<0.05 Significant	-	.24714	-	49	0.000<0.05 Significant
Hemocue	50	12.6500	2.97351			.5880	16.824			
	n	Mean	S.D	Correlation	Statistical inference	Mean	S.D	t	df	Statistical inference
Auto	50	12.0620	2.95441	.975	0.000<0.05 Significant	.0120	.66567	.127	49	.899>0.05 Not Significant
Span	50	12.0500	2.94779							
	n	Mean	S.D	Correlation	Statistical inference	Mean	S.D	t	df	Statistical inference
Hemocue	50	12.6500	2.97351	.973	0.000<0.05 Significant	.6000	.69429	6.111	49	0.000<0.05 Significant
Span	50	12.0500	2.94779							

**Descriptive Statistics**

	n	Min.	Max.	Mean	S.D
Age	50	21	70	47.36	14.659
Auto	50	6.00	19.10	12.0620	2.95441
Hemocue	50	6.40	19.90	12.6500	2.97351
Span	50	6.20	19.70	12.0500	2.94779

**Karl Pearson coefficient correlation relationship between auto, haemacu and their span**

	Mean	S.D	Auto	Haemacu	Span
Auto	12.0620	2.95441	1	.997(**)	.975(**)
Hemocue	12.6500	2.97351	.997(**)	1	.973(**)
Span	12.0500	2.94779	.975(**)	.973(**)	1
n			50	50	50

\*\* Correlation is significant at the 0.01 level

Statistical test: Karl Pearson coefficient correlation test was used the above hypothesis table

The above table indicates that there is a significant relationship between automated, Hemocue and Handyspan. Hence, the calculated value is less than table value (p\*\*<0.05). So the research hypothesis is accepted.

**DISCUSSION**

There are several reasons supporting the use of POCD devices, including those for Hb assessment, in clinical and laboratory practice. First, saving time is critical in several areas of health care, where a very rapid Hb measurement might be required to make immediate therapeutic decisions [6-8].

This might happen in any health care context where the clinical laboratory is too far, making turnaround time incompatible with a fast triage (e.g., in decentralized health care facilities with no support of a clinical laboratory unit within a network or those organized according to a hub-and-spoke model), or in hospital units where the fastest possible turnaround time from shipping a sample for Hb assessment to the core laboratory might still be insufficient (e.g., critical hemorrhages in the operating room, intensive care patients) [9, 10].

The availability of POCD for Hb assessment is also valuable due to the low amount of blood required by these devices in patients requiring critical venous access, especially neonates and those undergoing chemotherapy.

The use of POCD devices also represents the best option in the unfortunate circumstance of natural disasters, where there is a compelling need to convey laboratory technologies that can be easily transported, installed, and appropriately used outside the traditional laboratory environment.

Sports medicine is another ideal context for POCD, where rapid test results might guide the application of specific training regimens and testing when carried out with rigorous preanalytical and analytical requirements [8].

In all these situations, POCD devices such as the HemoCue and Handyspan might yield accurate Hb results within seconds, with a small amount of sample required and thereby less discomfort [9-11].

Our study reveals that there is no significant difference in the results obtained on statistical analysis of hemoglobin estimation by the above three methods-HemoCue, Handyspan and automated hematology analyzer coulter 780 [12-16].

Diagnostic accuracy of Hemoglobin estimation by point of care devices with Automated Hematology Analyzer Method has been proved in our study. Therefore, anyone of these methods can be used depending upon the accessibility and cost effectivity.

### CONCLUSION

It was concluded that the Hemoglobin (Hb) estimation done using point of care devices - Hemocue Hb 301 and Handyspan in spite of the different working principles were found to correlate with the standard Automated hematology analyzer coulter 780 method.

It is therefore recommended that for small samples and preliminary parameters like hemoglobin POCD methods can be employed since these are cost effective, easy in operation, requires less training and feasible to be used in field work. Moreover these PCOD methods have also been proven to have good diagnostic accuracy,

### REFERENCES

- [1] Vanzetti, G. An Azide-Methemoglobin Method for Hemoglobin Determination in Blood. *J. Lab. Clin. Med.* 1966, 67(1), 116-126.
- [2] Van Kampen, E. J., Zijlstra, W. G. Spectrophotometry of Hemoglobin and Hemoglobin Derivatives. *Adv. Clin. Chem.* 1983, 23, 199-257
- [3] Morris, L. D., Osei-Bimpong, A., McKeown, D., Roper, D., Lewis, S. M. Evaluation of the Utility of the HemoCue 301 Haemoglobinometer for Blood Donor Screening. *Vox Sang.* 2007, 93(1), 64-69.
- [4] Van de Louw, A., Lasserre, N., Drouhin, F., Thierry, S., Lecuyer, L., Caen, D., Tenailon, A. Reliability of HemoCue in Patients with Gastrointestinal Bleeding. *Intensive Care Med.* 2007, 33(2), 355-358.
- [5] Gomez-Simon, A., Navarro-Nunez, L., Perez-Ceballos, E., Lozano, M. L., Candela, M. J., Cascales, A., Martinez, C., Corral, J., Vicente, V., Rivera, J. Evaluation of Four Rapid Methods for Hemoglobin Screening of Whole Blood Donors in Mobile Collection Settings. *Transfus. Apher. Sci.* 2007, 36(3), 235-242.
- [6] Bahadur, S., Jain, S., Jain, M. Estimation of Hemoglobin in Blood Donors: A Comparative Study Using HemoCue and Cell Counter. *Transfus. Apher. Sci.* 2010, 43(2), 155-157.

- [7] Nkrumah, B., Nguah, S. B., Sarpong, N., Dekker, D., Idriss, A., May, J., Adu-Sarkodie, Y. Hemoglobin Estimation by the HemoCue® Portable Hemoglobin Photometer in a Resource Poor Setting. *BMC Clin. Pathol.* 2011, 11, 5.
- [8] Banfi, G., Drago, L., Lippi, G. Analytical Variability in Athletes Haematological Testing. *Int. J. Sports Med.* 2010, 31(3), 218.
- [9] Mimoz, O., Frasca, D., Medard, A., Soubiron, L., Debaene, B., Dahyot-Fizelier, C. Reliability of the HemoCue® Hemoglobinometer in Critically Ill Patients: A Prospective Observational Study. *Minerva Anesthesiol.* 2011, 77(10), 979–985.
- [10] Seguin, P., Kleiber, A., Chanavaz, C., Morcet, J., Malledant, Y. Determination of Capillary Hemoglobin Levels Using the HemoCue System in Intensive Care Patients. *J. Crit. Care* 2011, 26(4), 423–427.
- [11] Lamhaut, L., Apriotesei, R., Combes, X., Lejay, M., Carli, P., Vivien, B. Comparison of the Accuracy of Noninvasive Hemoglobin Monitoring by Spectrophotometry (SpHb) and HemoCue® with Automated Laboratory Hemoglobin Measurement. *Anesthesiology* 2011, 115(3), 548–554.
- [12] Spielmann, N., Mauch, J., Madjdpour, C., Schmutz, M., Weiss, M., Haas, T. Accuracy and Precision of Hemoglobin Point-of-Care Testing during Major Pediatric Surgery. *Int. J. Lab. Hematol.* 2012, 34(1), 86–90.
- [13] Valuation of alkaline hematin D-575 method for hemoglobin estimation in the east africa. *Bulletin of the world health organization*, 1994, 72(6); 937-941..
- [14] N.M.M. Moharram et al., International collaborative assessment study of the AHD 575 method for the measurement of blood hemoglobin. *Eastern Mediterranean Health Journal*, 2006 12(6); 772-734.
- [15] H.UWE. Wolf and et.al., Alkaline hematin D-575 a new tool for the determination of hemoglobin as an alternative to cyanhaemoglobin method. Description of the method (i). *Clinica Chimica Acta*, 1984, 136; 83-93.
- [16] H.UWE. Wolf and et.al., Alkaline hematin D-575 a new tool for the determination of hemoglobin as an alternative to cyanhaemoglobin method. Description of the method (ii). standardisation of the method using pure chlorhaemin., 1984, 136; 95-104.