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Diagnostic accuracy of hemoglobin estimation by point of care devices – A comparative study with the automated hematology analyzer

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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 – Hemo Cue 301 and Handy span, a portable hemo calorimeter to assess haemoglobin against the automated hematology analyzer Coulter 780. Hb was assessed in fifty blood samples by utilizing the Hemo Cue, Handy span and Automated hematology analyzer Coulter 780. The results by Hemo Cue and Handy span 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 Hemo Cue and portable hemo calorimetry (Handy span) are as accurate as the Automated hematology analyzer Coulter 780.

Keywords: Hemo globin, Cyan met hemo globin, Auto mated methods, Hemo Cue, Handy span, Point of care devices (POCD).

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 Hemo Cue, portable hemo calorimetry (Handy span) 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.

Aims and objectives

The aims and objectives of the current study are to

- compare the haemoglobin values obtained by automated hematology analyzer Coulter 780 with the point of care devices (POCD) such as Hemo cue and portable hemo calorimetry (Handy span) 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 Hemo cue, Handy span and Automated hematology analyzer Coulter 780 method.

Hemocuehb 301 method

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

Fig 1: Hemocue HB 301

Handy span 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 hemo globin concentration in blood.

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

Fig 2: Handy span.

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 hemi globin cyanide method, the reference method of choice hemoglobinometry recommended by the international committee for standardization in hematology.

Fig 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
Total	50	100.0

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.

One-way ANOVA difference between age of the respondents and their method of Auto, Hemocue and Handy Span

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

Statistical test: One way ANOVA 'f' test was used the above table

The above table auto methods of mean ± S.D values from 21 to 30yrs age group (n=9) 12.6778 ± 2.23594, 31 to 40yrs age group (n=5) 14.7800 ± 0.95760, 41 to 50yrs age group (n=12) 11.52.50 ± 2.86773, 51 to 60yrs age group (n=15) 10.6733 ± 2.97453 and remaining 61 to 70yrs age group (n=9) 12.9667 ± 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
Auto				
Male	33	13.1091	2.78336	t=3.987 df=48
Female	17	10.0294	2.14148	0.000<0.05 Significant
Hemocue				
Male	33	13.7061	2.79586	t=3.998 df=48
Female	17	10.6000	2.16304	0.000<0.05 Significant
Span				

Male	33	13.0939	2.77409	t=3.983 df=48
Female	17	10.0235	2.14695	0.000<0.05 Significant

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	-.5880	.24714	-16.824	49	0.000<0.05 Significant
Hemocue	50	12.6500	2.97351							
	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 handy span. 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.

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 Hemo Cue and Handy span 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-Hemo Cue ,handy span and automated hematology analyzer coulter 780 . 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 handy span 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,

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