

Comparison between the HemoCue® and an automated counter for measuring hemoglobin

Comparação entre o HemoCue® e um contador automático para determinação de hemoglobina

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Keywords

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Descritores

Anemia, diagnóstico. Anemia, prevenção e controle. Hemoglobina, análise. HemoCue. Gravidez.

Abstract

To determine the precision and agreement of the hemoglobin (Hb) measurements in capillary and venous blood samples by the HemoCue® and an automated counter. Hb was determined by both equipments in blood samples of 29 pregnant women. The HemoCue® showed low repeatability of Hb measurements in duplicate in capillary (CR=0.53 g/dL, CV=13.6%) and venous blood (CR=0.53 g/dL, CV=13.6%). Hb measurements in capillary blood were higher than those in venous blood (12.4 and 11.7 g/dL, respectively; $p<0.05$). There was high agreement between Hb in capillary blood by the HemoCue® and in venous blood by the counter ($r_{icc}=0.86$; $p<0.01$), and also between the diagnosis of anemia by both equipments ($k=0.81$; $p<0.01$). The HemoCue® seems to be more appropriate for capillary blood and require training of the measurers.

Resumo

Com o objetivo de avaliar a precisão e concordância na determinação de hemoglobina (Hb) em sangue capilar e venoso, utilizando-se o HemoCue® e um contador automático, foram estudadas 29 gestantes. O HemoCue® apresentou baixa repetibilidade para as medidas em duplicata em sangue capilar (CR=0,53 g/dL; CV=13,6%) e venoso (CR=0,53 g/dL; CV=13,6%). As medidas de Hb obtidas em sangue capilar foram mais altas do que as obtidas em sangue venoso (12,4 e 11,7 g/dL, respectivamente; $p<0,05$). Verificou-se alta concordância entre medidas de Hb em sangue capilar obtidas pelo HemoCue® e em sangue venoso pelo contador ($r_{icc}=0,86$; $p<0,01$), bem como entre os diagnósticos de anemia realizados nos dois equipamentos ($k=0,81$; $p<0,01$). O HemoCue® parece ser mais apropriado para análise de Hb em sangue capilar, mas é necessário um treinamento dos analisadores.

INTRODUCTION

Anemia is a Public Health problem worldwide, especially in pregnant women, because of their increased requirements for hematopoietic nutrients to achieve augmented erythropoiesis during pregnancy and for storage by the fetus.

Hemoglobin (Hb) concentration is the most used

parameter to detect anemia, usually determined by portable hemoglobinometers, such as the HemoCue® (Blood Hemoglobin Photometer - HemoCue AB, Angelholm, Sweden). Some advantages of this equipment are simplicity and speed in measuring Hb, requiring just a single drop of blood collected in a special cuvette. It is claimed by the manufacturer that the HemoCue® is suitable for Hb estimation using capillary, venous and arterial blood samples.

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Previous evaluations of the HemoCue® have revealed conflicting results, with some studies presenting a good precision and accuracy of this equipment, and others emphasizing the need of a better methodological control.²⁻⁴

The aims of this study were to determine the precision and agreement of hemoglobin measurements in capillary and venous blood samples by both HemoCue® and a counter in a group of pregnant women.

METHODS

Twenty-nine (29) pregnant women participated in the study and were enrolled when they came to one of the hospitals for delivery. All of them had to sign a consent form which included permission to collect blood samples. The Ethics Committee of the Faculdade de Saúde Pública approved the research protocol.

Paired capillary blood samples were collected by finger prick in the middle finger of left hand, using two of the HemoCue® specific cuvettes, after cleaning and massaging the finger to stimulate blood flow. The first and second blood drops were collected and immediately analyzed. A trained nurse performed sampling, according to the manufacturer's recommendation.¹

Venous blood samples were collected into Vacutainer® tubes with EDTAK₃ (Becton Dickinson Vacutainer® System), by the same nurse. The tubes were sent to the medical laboratory of the Hospital São Vicente de Paula to measure Hb in duplicate on a counter Cell Dyn 3000. Hb was also measured in venous blood by the HemoCue®.

Since the volume of capillary blood samples was small, it was not possible to measure Hb in capillary blood by the Cell Dyn 3000.

The precision of the two equipments was assessed using the coefficient of repeatability (CR) and coefficient of variation (CV). Paired Student's t-test was used to compare the means of Hb obtained by both HemoCue® and counter. The intra-class correlation coefficient (r_{icc}) was determined to evaluate the agree-

ment between the Hb measurements obtained by the two equipments. To evaluate the agreement between the diagnoses of anemia obtained by the HemoCue® and by the Cell Dyn 3000, Kappa's statistics was used. The Hb cutoff point to classify pregnant women as anemic was <11 g/dL.

RESULTS

The results showed that HemoCue® has a lower precision than Cell Dyn 3000, for analyses of both biological samples since because of the low repeatability (CR - Cell Dyn 3000 venous blood =0.08; HemoCue® venous blood =0.53; HemoCue® capillary blood =0.54) and a high variability (CV - Cell Dyn 3000 venous blood = 11.8; HemoCue® venous blood =17.0; HemoCue® capillary blood =13.6). Paired Hb measurements presented a higher variation when performed in venous blood, compared with capillary blood.

The Table shows the means and the r_{icc} for the Hb measurements in capillary and venous blood by the HemoCue® and in venous blood by the counter Cell Dyn 3000. There was no significant difference between the Hb measurements determined in venous blood by the HemoCue® and by the counter ($p=0.768$). However, the r_{icc} value was not so high, although significant ($r_{icc}=0.60$; $p<0.01$).

The mean value of Hb obtained in capillary blood by the HemoCue® was higher than the mean value of Hb obtained in venous blood by both HemoCue® ($p=0.021$) and Cell Dyn ($p=0.002$). However, the r_{icc} was high between the Hb measurements determined by the HemoCue® in capillary blood and by the counter ($r_{icc}=0.86$; $p<0.01$).

The prevalences of anemia in pregnant women obtained by the HemoCue® using capillary blood (24%) and by the Cell Dyn 3000 (24%) were similar, and there was a good agreement between the diagnoses ($k=0.81$; $p<0.01$).

DISCUSSION

Portable photometers have recently been used for

Table - Comparison between capillary and venous hemoglobin determinations by HemoCue® and Cell Dyn 3000.

Equipment/Blood Sample (N=29)	Mean Hb (SD)	P*	r_{icc} **	P***
HemoCue®/ venous vs HemoCue®/ capillary	11,7 (2,0) 12,4 (1,5)	0.021	0.61	<0.01
HemoCue®/ venous vs Cell Dyn 3000	11,7 (2,0) 11,6 (1,3)	0.768	0.60	<0.001
HemoCue®/ capillary vs Cell Dyn 3000	12,4 (1,5) 11,6 (1,3)	0.001	0.86	<0.001

*paired t-Student test

**intra-class correlation coefficient

***test for intra-class correlation coefficient =0

SD: Standard deviation

quick assessment of Hb concentrations. In this study, it was analyzed the precision and agreement of the HemoCue®, a portable hemoglobinometer widely used for analysis of both capillary and venous blood samples.

The Hb measurement performed by HemoCue® is based on a method described by Vanzetti.⁶ The sodium desoxicholate present in the cuvette hemolyze red cells, and the free Hb is converted into methemoglobin by sodium nitrite. Then, methemoglobin is converted into azide-methemoglobin by sodium azide. Transmitted light absorbance is measured at 565 and 880 nm to compensate for any turbidity in the sample.

According to the study results, the HemoCue® has a lower precision than the Cell Dyn 3000 for analyses of both blood samples. Similarly, some studies have also found a high variation between paired Hb measurements obtained by the HemoCue® when compared to a counter.

Chen et al,² studying forty-two (42) intensive care unit patients, compared the Hb measurements obtained in capillary, arterial, and venous blood samples, analyzed by the HemoCue® and an automated counter. According to the authors, the HemoCue® was found to give repeatable results when Hb estimates were made using either venous or arterial samples, but capillary estimates were found to be significantly less repeatable.

Conway et al,⁴ investigating a group of forty (40) health adults, observed a wide variation between paired Hb measurements determined in capillary samples by the HemoCue®. The differences were higher than 10.0 g/L (1.0 mg/dL), comparing the measure-

ments conducted by health visitors with the ones by biomedical scientists, who received identical training on the use of the HemoCue®.

According to Cogswell et al,³ the collection of capillary samples for the diagnosis of anemia and iron deficiency anemia is not appropriate, rather than an inadequacy of the HemoCue®. It is important to point out that the measurements in capillary blood samples have been reported to be significantly higher than the corresponding values in venous samples.⁵

Although the Hb measurements obtained by HemoCue® using capillary samples were higher than the ones obtained by the counter, the correlation between these measurements was good ($r_{icc}=0.86$; $p<0.01$). In addition, the prevalence of anemic pregnant women was similar using both equipments (24%), and there was a good agreement in the diagnoses ($k=0.81$; $p<0.01$).

These results suggest that the HemoCue® show a higher variability between measurements in duplicate, especially using capillary blood samples. The Hb measurements obtained by the HemoCue® in capillary blood were always higher than those obtained in venous blood, regardless of the equipment. Nevertheless, the Hb measured by the HemoCue® in capillary blood showed a good correlation with the Hb measurements by the counter.

Undoubtedly, the HemoCue® is useful in both clinical and epidemiological settings, especially in situations of emergency. However, it is more appropriate to use capillary blood samples, considering the sampling error. In addition, it is necessary to have a thorough training to minimize poor repeatability of this equipment.

REFERENCES

1. ASEM-NPBI Produtos Hospitalares. *Manual Hemocue® blood hemoglobin photometer*. São Paulo; 1998.
2. Chen PP, Short TG, Leung DHY, Oh TE. A clinical evaluation of the HemoCue haemoglobinometer using capillary, venous and arterial samples. *Anaesth Intensive Care* 1992;20:497-503.
3. Cogswell ME, Parvanta I, Yip R, Brittenham GM. Inaccuracy of capillary hemoglobin testing for the detection of anemia and iron deficiency during pregnancy. *Am J Epidemiol* 1998;147(Suppl 5):206.
4. Conway AM, Hinchliffe RF, Earland J, Anderson L M. Measurement of haemoglobin using single drops of skin puncture blood: is precision acceptable? *J Clin Pathol* 1998;51:248-50.
5. Daae LN, Halvorsen S, Mathisen PM, Mironska K. A comparison between haematological parameters in "capillary" and venous blood from healthy adults. *Scand J Clin Lab Invest* 1998;48:723-6.
6. Vanzetti G. An azide-methemoglobin method for hemoglobin determination in blood. *J Lab Clin Med* 1966;67:116-26.