An evaluation of the HemoCue for measuring haemoglobin in field studies in Jamaica

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The HemoCue system utilizes the principle of oxidation of haemoglobin to hemiglobin by sodium nitrite and the subsequent conversion of hemiglobin to hemiglobinazide by sodium azide. The reagents for these reactions are contained within a small disposable microcuvette of approximately 10 µl in volume. A venous or capillary sample is introduced into the microcuvette by capillary action and, after reaction with the reagents, the absorbance is read in the HemoCue photometer at 565 and 880 nm. The haemoglobin concentration is then displayed as a digital reading, in either g/dl or mmol/l in 15–45 seconds.

We compared haemoglobin values obtained by the HemoCue system with those from the Coulter Counter S-Plus IV in 366 pregnant women in urban Jamaica, and found a highly significant correlation (r = 0.78, P <0.01). However, because of the convenience and ease of use of this instrument and considering the relatively high cost, we recommend it for use only as a research tool in field studies where accurate and rapid haemoglobin determinations are required.

Introduction

Anaemia has been shown to be a public health problem in the English-speaking Caribbean, with prevalences averaging 27–75% and 11–75% in pregnant women and preschool-age children, respectively. Severe anaemia, with a haemoglobin concentration below 8.0 g/dl (5 mmol/l), is found in approximately 6% of pregnant and lactating women and 11% of preschool children in some of these countries (*1*, *2*).[a]

The problem of measuring this anaemia in the field remains a major obstacle in some Caribbean countries. This paper describes the field testing of the HemoCue system (from HemoCue AB, Helsingborg, Sweden) and discusses its advantages and limitations as a research tool for determining the haemoglobin level in the region. The evaluation was done as part of a larger study designed to investigate the efficacy and side-effects of various iron formulations during pregnancy.

The HemoCue system

The HemoCue blood haemoglobin testing system consists of a direct reading haemoglobinometer and disposable microcuvettes which contain the reagents. Each microcuvette is approximately 10 µl in volume, and contains deoxycholate to haemolyse the erythrocytes, sodium nitrite to oxidize haemoglobin to hemiglobin (methaemoglobin, Hi), and sodium azide to convert hemiglobin to hemiglobinazide (HiN_3).

The blood sample, which can be obtained either by venepuncture or by a finger prick, is drained into the cuvette by capillary action and mixes with the reagents. The absorbance is then read in the HemoCue photometer, at 565 and 880 nm. The latter measurement compensates for any turbidity in the sample due to lipids, high leukocyte count, etc. The photometer calculates the haemoglogin concentration in mmol/l or g/dl and displays the results as a digital reading in 15–45 seconds. All readings must be done within 10 minutes of filling the cuvette. The unit is powered either by connecting to the mains electrical supply or via a rechargeable nickel-cadmium battery pack.

Materials and methods

Haemoglobin values, measured on pregnant women in the health centres using the HemoCue system, were compared with those measured on the Coulter Counter S-Plus IV. Data were collected in eight maternal and child health centres in Kingston and St. Andrew, and Spanish Town, Jamaica, over a period of approximately one year by two teams, under the direction of two field supervisors. The haemoglobin estimations were carried out by members of the trained team.

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[a] **Simmons WK.** *Anaemia in the Caribbean: its prevalence and causes* (unpublished document CFNI-J-10-83, 1983).

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The criteria for inclusion of pregnant women in the larger study, under which the HemoCue system was evaluated, were:

— the mother should be attending the antenatal clinic for the first time;

— gestation should be between 14 and 22 weeks;

— the mother's age should be between 16 and 35 years;

— she should not currently be on iron supplements;

— haemoglobin as measured by the HemoCue system should fall in the range of 8.0–12.0 g/dl.

From women who fulfilled these criteria on entry, 3 ml of venous blood was collected in freeze-dried EDTA and kept on ice, to be later transferred to the Iron Monitoring Laboratory at the Caribbean Food and Nutrition Institute, Kingston, Jamaica. From here all samples were taken to the Sickle Cell Research Laboratory where haemoglobin and other haematological determinations were performed on the Coulter Counter. As far as possible, all readings were done within twenty four hours of the venepuncture. The two sets of haemoglobin measurements taken on entry to the antenatal clinics were compared.

Results

Results were obtained for 366 women. A correlated sample *t*-test yielded a small difference in means ($t = 4.97$, $P < 0.01$, 365 df) with slightly wider standard deviations from the Coulter Counter (Table 1).

The two sets of haemoglobins correlated highly ($r = 0.78$, $P < 0.01$, $n = 366$) and the scattergram is shown in Fig. 1.

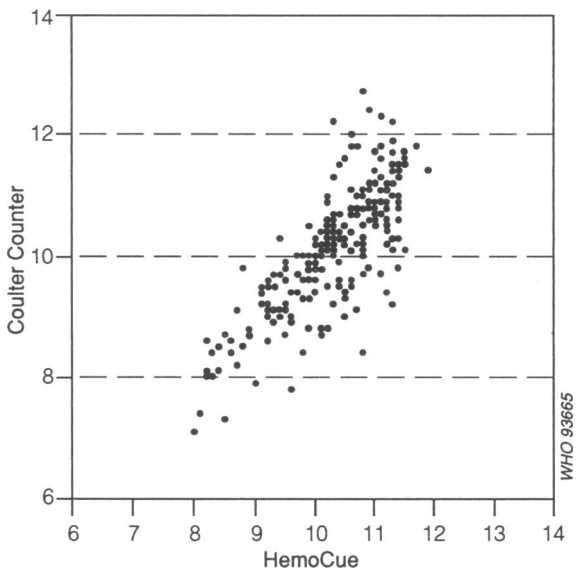
Discussion

The measurement of haemoglobin constitutes the first step in the investigation of anaemia. In clinical laboratories, the cyanomethaemoglobin method remains one of the most widely used for its determination (3), but fully automated systems such as the Coulter S-Plus III or the Coulter S-880 have greatly enhanced the ease of determination.

Table 1: **Mean and standard deviation values for haemoglobin from pregnant women**

	No. of women	Mean (g/dl)	S.D.
HemoCue	366	10.3	0.84
Coulter Counter	366	10.1	1.03

Fig. 1. **Scattergram of haemoglobin values (g/dl) in 366 pregnant women, as determined by HemoCue and by Coulter Counter.**



In Third World countries, where Coulter Counters, spectrophotometers and other sophisticated laboratory equipment are not always available, there needs to be simple, inexpensive methods that can reliably determine haemoglobin in field studies as well as in the health centres. Many different methods have been used with some degree of success in the English-speaking Caribbean. These include the Tallquist, copper sulfate, Spencer and Sahli (4) techniques. At present, the Spencer method is the most widely accepted. However, in one island with an exceptionally heavy clinic load (one or two nurses or midwives with 60–70 patients), it is felt that haemolysing the blood samples is far too time-consuming and puts excessive pressure on the limited staff.

The correlation reported here is slightly lower than those reported by other investigators who compared the HemoCue with the Coulter Counter and the cyanomethaemoglobin methods (*5*, *6*).[b] This may be explained by the fact that we selected a limited range of haemoglobin values (8–12 g/dl), whereas other researchers considered a wider range. These other studies were performed under controlled labor-

[b] **Bridges N, Parvin RM, Van Assendelft OW.** *Evaluation of a new system for haemoglobin measurement.* Reprinted from American Clinical Products Review, 1987.

atory conditions, but our venepunctures and haemoglobin determinations on the HemoCue were carried out in the health centres and we estimated each haemoglobin on the Coulter Counter within 24 hours of blood withdrawal. It is unlikely that this delay would have affected the Coulter values since samples were stored at 4 °C.

The HemoCue was found to be convenient and easy to use by field workers in our study. This is in agreement with conclusions from another field study conducted in Peru where the HemoCue was found to be simple to use even by unskilled workers (*7*). In fact, when we introduced the HemoCue in another Caribbean country for use in an island-wide anaemia survey, the enthusiasm for the instrument was great.

In this study the HemoCue was tested by field workers especially trained in its use, and not by regular clinic staff under normal clinic conditions. Because of this, coupled with the relatively high cost of the instrument (US$ 425) and the cuvettes (US$ 0.80 each), we are unable to recommend its use routinely in our clinics. We do, however, recommend its use as a research tool in field studies where an accurate and rapid measurement of the haemogobin level is needed.

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Résumé

Evaluation de l'HemoCue pour le dosage de l'hémoglobine lors d'études sur le terrain à la Jamaïque

L'anémie est depuis longtemps un problème majeur de santé publique dans les Caraïbes anglophones. Une anémie sévère (hémoglobine <8,0 g/dl) s'observe chez environ 6% des femmes enceintes et allaitantes et, dans certains pays, chez 11% des enfants d'âge préscolaire. La difficulté de mesurer exactement l'hémoglobine sur le terrain constitue un obstacle dans certains de ces pays. Nous avons évalué le système HemoCue (produit par HemoCue AB, Helsingborg, Suède) comme moyen de procéder à un dosage rapide et exact de l'hémoglobine lors d'études sur le terrain dans les pays en développement.

Le système HemoCue utilise le principe de l'oxydation de l'hémoglobine en méthémoglobine par le nitrite de sodium, puis la conversion de la méthémoglobine en azoture de méthémoglobine par l'azoture de sodium. Les réactifs sont contenus dans une microcuve jetable d'environ 10 µl de volume. Un échantillon de sang veineux ou capillaire est introduit dans la microcuve par capillarité et, après mise en présence des réactifs, l'absorbance est lue sur le photomètre à 565 et 880 nm. La concentration en hémoglobine est alors affichée au bout de 15 à 45 secondes, soit en g/dl soit en mmol/dl.

Nous avons comparé les valeurs de l'hémoglobine obtenue par le système HemoCue avec les valeurs obtenues sur Coulter Counter S-Plus IV chez 366 femmes enceintes provenant de zones urbaines de la Jamaïque. Un prélèvement de sang veineux a été recueilli sur EDTA lyophilisé chez des consultantes de dispensaires de santé maternelle et infantile situés dans un rayon d'une vingtaine de kilomètres du laboratoire de recherche. Le dosage de l'hémoglobine a été réalisé au dispensaire avec le système HemoCue, et le reste de l'échantillon a été maintenu sur de la glace et expédié au laboratoire de recherche pour dosage de l'hémoglobine sur Coulter Counter S-Plus IV. Cette dernière détermination a été effectuée dans les 24 heures suivant la mesure sur HemoCue. On a observé une corrélation hautement significative ($r = 0,78$, $P<0,01$) entre les deux séries de mesures.

Cette corrélation élevée, associée à la commodité et à la facilité d'emploi de l'HemoCue, autorise à recommander son emploi comme outil de recherche lors d'études sur le terrain où il est nécessaire d'obtenir une mesure exacte et rapide de l'hémoglobine. Nous ne pouvons toutefois le recommander pour l'utilisation en routine en raison de son coût relativement élevé (US$ 425 pour l'appareil et US$ 0,80 pour chaque microcuve).

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