

## ORIGINAL ARTICLE

## Evaluation of the HemoCue compared with the Coulter STKS for measurement of neonatal haemoglobin

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**Objective:** To compare the measurement of haemoglobin concentration ([Hb]) using the HemoCue haemoglobinometer with that using the Coulter STKS haemoglobinometer.

**Design:** Thirty two EDTA samples were taken from neonates. [Hb] was measured in these samples using the HemoCue; the samples were then transferred to the haematology laboratory for [Hb] determination with the Coulter STKS. In addition, [Hb] was determined in 50 different random EDTA neonatal samples already held in the laboratory, using the HemoCue and Coulter STKS.

**Patients:** Neonates in the intensive care and low dependency Units of the Royal Devon and Exeter Hospital.

**Interventions:** Samples were collected from arterial lines or by venepuncture or heel prick into an EDTA bottle.

**Main outcome measures:** [Hb] using the HemoCue and Coulter STKS methods.

**Results:** The mean [Hb] measured using the HemoCue was 150.3 g/l (range 78–215) compared with 152.8 g/l (range 78–217) measured using the Coulter STKS, with a mean of the differences of 2.5 g/l. The standard deviation of the differences of the 82 samples was 3.73 g/l. The limits of agreement of the two methods (mean difference  $\pm$  2SD) were  $-4.8$  to  $+9.8$  g/l.

**Conclusion:** With adequate training and monitoring, the HemoCue can be used directly on the neonatal unit for rapid determination of [Hb] to within 7.5 g/l compared with the laboratory Coulter STKS, using much smaller sample volumes.

Neonates are more likely to be transfused than any other patients in hospital.<sup>1</sup> Anaemia can result from haemorrhage, haemolysis, or failure of erythropoiesis, or be iatrogenic from frequent testing. Sampling may be technically difficult and distressing to the baby and observing parents. When receiving a transfusion, the neonate is vulnerable because of its small size, and exposure to multiple potential donors and metabolic disturbances can occur.<sup>2</sup>

At present in our hospital, haemoglobin concentrations ([Hb]) are determined using the Coulter STKS, which measures them photometrically after lysis of the red blood cells and conversion of free Hb into a cyanide-containing compound.<sup>3</sup> It requires 200  $\mu$ l of blood and has an accuracy of 2%.<sup>4</sup> Although 200  $\mu$ l may be sufficient, the haematology department request 500  $\mu$ l, as the commonest cause of error with the Coulter STKS is with small samples, which then need to be repeated.

Previous studies have validated the use of the HemoCue haemoglobinometer (HemoCue Ltd, Sheffield, Yorkshire, UK) for near patient testing of [Hb] in children and fetuses.<sup>5–7</sup> It measures [Hb] by converting haemoglobin into haemoglobinazide, and uses agents of relatively low toxicity.<sup>8</sup> It provides a result almost immediately with a sample of only 10  $\mu$ l of blood.

We undertook a study to determine whether the HemoCue could be used on the neonatal unit of a district general hospital in preference to the Coulter STKS to measure [Hb], thus reducing iatrogenic anaemia, making sampling easier, and providing a result quickly.

## METHOD

## Principle and operation of the HemoCue

The HemoCue is a device (height 90 mm, width 160 mm, depth 210 mm, weight 250 g) that can be operated using battery or mains electricity. The cuvettes for the HemoCue

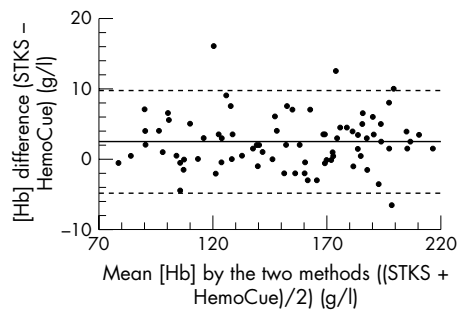
contain the following dried reactants: sodium desoxyate to haemolyse red blood cells; sodium nitrate to convert haemoglobin into methaemoglobin; sodium azide to convert the methaemoglobin into haemoglobinazide. To prevent decay of these reactants from exposure to the atmosphere, the cuvettes are kept in a sealed container. Whole blood (10  $\mu$ l) is collected in two cuvettes by capillary action, avoiding the formation of air bubbles. Excess blood is removed from the outside of the cuvette, which must be placed in the cuvette holder of the HemoCue within 10 minutes. Light absorbance is measured at 570 nm and 880 nm to compensate for any turbidity in the sample. [Hb] is calculated using a programmed algorithm, and the result is displayed usually within 45 seconds. If there is a difference of more than 3 g/l between the two cuvettes, the test should be repeated.

## Comparison of the HemoCue with the Coulter STKS

Ethical approval for the study was obtained from the local research ethics committee. There were two sample groups: bedside and laboratory. Thirty two samples (bedside) were collected into EDTA bottles by venepuncture or heel prick or were taken from arterial lines. HemoCue readings were taken from each of the EDTA samples ( $2 \times 10$   $\mu$ l of whole blood). The EDTA samples were then forwarded to the haematology department for measurement of [Hb] using the Coulter STKS. Fifty separate randomly selected neonatal samples (laboratory) already held in the laboratory were also analysed by the two methods. This produced a total sample size of 82.

## RESULTS

For the 82 samples, there was no statistically significant difference between the means by *t* test. The mean [Hb] measured by HemoCue was 150.3 g/l (range 78–215) and that measured by the Coulter STKS was 152.8 g/l (range 78–217), with a mean of the differences of 2.5 g/l. The standard deviation of the differences was 3.73 g/l. The limits of agreement of



**Figure 1** Plot of the difference between the results obtained by the two methods against the mean of the results obtained by the two methods of haemoglobin measurement ( $n = 82$ ). The dashed lines indicate the limits of agreement. [Hb], Haemoglobin concentration.

the two methods (mean difference  $\pm$  2SD) were  $-4.8$  to  $+9.8$  g/l (fig 1).

## DISCUSSION

Neonates in the intensive care unit require frequent [Hb] measurements. The HemoCue is capable of producing a result within minutes. This speed and the small sample volume required have advantages for patient management and also offer potential savings in cost. The small sample volume required also benefits the growing neonate in the low dependency unit, who has weekly [Hb] checks.

We regarded as clinically significant a [Hb] difference of greater than 10 g/l between the HemoCue and the Coulter STKS. This level of clinical significance was used to determine

the sample size. In our study, 95% of the values were within 7.5 g/l. On the basis of our level of clinical significance, the HemoCue is therefore an acceptable method of determining [Hb] if used correctly. We found a very wide range of [Hb] values, reflecting the [Hb] of the newborn and that of the long stay or acutely ill neonate found on neonatal units. Our study shows that the HemoCue is accurate over a wide [Hb] range.

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**The effect of brief neonatal exposure to cows' milk on atopic symptoms up to age five.** M H de Jong, V T M Scharp-van der Linden, R Aalberse, et al.