Evaluation of the Hemocue Portable Hemoglobinometer After Major Joint Arthroplasty

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Abstract: We evaluated the potential use of the Hemocue (Hemocue AB, Sweden) portable hemoglobinometer on the 1st postoperative evening after major joint arthroplasty. We compared hemoglobinometer values with conventional Coulter counter laboratory analysis in a population of 67 patients. The hemoglobinometer proved practical, economical, and accurate in general, although 2 outlying values were severe enough as potentially to influence clinical decision making. Potential causes and solutions are discussed. **Key words:** joint arthroplasty, hemoglobin measurement, hemoglobinometer, blood transfusion.

Portable, immediate hemoglobin measurement devices have many potential advantages in primary and secondary medical situations, including accessibility, ease of use, and cost. Authors have described evaluation of such devices in general practice [1], in the emergency department [2], during cardiac surgery [3], in the field [4], and in pediatrics [5]. The Hemocue hemoglobinometer (Hemocue AB, Sweden) has been reported to produce accurate results in the aforementioned settings. We decided to use this device (with conventional laboratory Coulter counter analysis as the control) in the setting of postoperative major joint arthroplasty hemoglobin measurement.

Provided that vital parameters are stable, blood transfusion normally is indicated when hemoglobin levels decrease to ≤10 g/dL [6]. A large multicenter trial showed that 57% of patients undergoing hip arthroplasty and 39% of patients undergoing knee arthroplasty required postoperative blood transfusion [7]. This figure would be expected to be higher in centers in which a high proportion of arthroplasties are revision procedures.

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Materials and Methods

Hemocue works on a photometric principle measuring azidemethemoglobin formation: The erythrocytes are lysed and the addition of NO_2^- converts hemoglobin to methemoglobin, which is converted to azidemethemoglobin by the addition of a further N_3^- [8]. The machine consists of an A4 battery–powered box with a drawer for the insertion of a plastic microcuvette.

During a period of 12 months, 67 patients who underwent shoulder, hip, or knee primary or revision arthroplasty were recruited to the study. No patients affected by known clotting disorders were included. On the evening of surgery, 1 venous blood sample was taken by medical staff and sent to the laboratory for Coulter analysis, while nursing staff took a capillary sample for analysis by Hemocue.

The capillary samples were obtained as follows: i) The middle or index finger was selected, and a microlance for fingertip capillary blood glucose analysis was used to puncture the skin; ii) the first 2 drops of blood were obtained, then discarded; and iii) the third drop was applied to the microcuvette.

Single-point calibration by a reference cuvette was done before each measurement [8].

The data obtained from Hemocue and laboratory measurement were compared by analysis of paired sample differences in absolute values and percentage differences. Student's *t*-test for paired samples was applied to test for significant differences. Correlation and linear regression analysis also was performed on the data. Student's *t*-test was performed on the correlation coefficient to investigate whether this was significantly different from 0. The F test was used to determine the significance of the regression slope parameter. A P value $<.05$ was considered significant.

Results

Hemoglobin levels obtained from Hemocue were plotted against those from the hospital's laboratory; this gave a distribution shown in Fig. 1. Main statistics are displayed in Table 1. Differences between the laboratory reference values and Hemocue values were deemed not to be significant. Conversely, values of the correlation and the regression coefficient were statistically significant. Analysis of figures revealed that 54 of the 67 paired samples gave a difference of $< \pm 10\%$. Two samples were noted to be outliers with a percentage difference of 59.1% and −46.3%.

Discussion

For Hemocue to be an acceptable method of hemoglobin measurement, it would have to be proved to be precise and accurate. In this study, the mean difference between laboratory and Hemocue values was encouraging (−0.17 g/dL). The SDs were comparatively disappointing (± 1.28 g/dL); this compares with a mean and SD of 0.4 ± 0.4 g/dL obtained by McNulty et al [3] and 0.6 ± 0.6 g/dL by Rippmann et al [9]. Our correlation coefficient r (0.82) between Hemocue and laboratory values lies in the middle ground compared with the literature, where r is quoted as 0.97 [7], 0.94 [10], 0.996 [11], and 0.96 [2] versus 0.61 [1]. The highest correlation is found in studies conducted under tight laboratory conditions or in which pooled samples of blood have been taken, whereas the last-mentioned figure was obtained in general practice using capillary samples taken by inexperienced operators. An early study using Hemocue in an emergency department gave an r of 0.89 [2], and a field study in Jamaica [4] gave a correlation of 0.78. It is not surprising that our r value correlates well with the latter 2 studies being conducted in a hospital but nonlaboratory setting by nontechnical staff.

Examination of the distribution plot reveals that the SDs are influenced heavily by the presence of 2 outliers at +59.1% and −46.3%, and recalculation without these 2 outliers reduces the SD to 0.75. A plausible explanation of this phenomenon was given by Conway et al [12], who showed that the addition of ethylenediaminetetraacetic acid to sample tubes before analysis significantly improved accuracy of data, reducing the percentage of results ± 1 g/dL from 60% to 0% (n = 20). A study by Chen et al [13] showed a significant increase in variation (coefficient of variation, 8% vs 2%) with capillary samples compared with venous samples. It would be reasonable to suggest that the increase in accu-

Table 1. Summary of Results and Statistics

	Hemocue Hb	Laboratory Hb	Differences (Hemocue − Laboratory Hb)
n	67	67	67
Mean	10.67	10.85	−0.17 (−1.43%)
Range	6.5–15.6	6.7–15.3	0–−6.2
Distribution	Normal	Normal	Normal
95% CI			±0.31
SD			±1.28 (±11.83%)
t-test			$P > .3$

Hemocue Hb Plotted vs Laboratory Hb

Correlation coefficient (r)	0.82
R^2	0.67
Regression coefficient	0.92
t-test	$P < .0001$
F test	$P < .0001$

Hb, hemoglobin; CI, confidence interval.

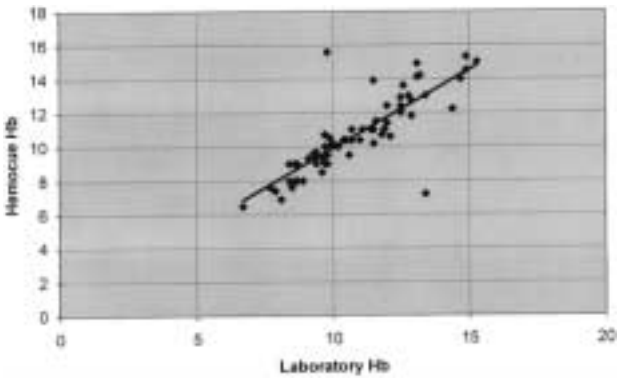

Fig. 1. Plot of hemoglobin (Hb) measurement by Hemocue versus laboratory analysis.

racy could be due at least in part to the decreased likelihood of clotting in the venous sample.

Conclusion

Hemocue is quick to use, is portable, and potentially can be used in circumstances in which laboratory facilities are not available. Even in a hospital setting, significant time savings are possible using such a system. Additionally, cost savings (in the United Kingdom, about 90% for a single test) are apparent over laboratory testing. Previous studies have been favorable. The paradox is, however, that the most accurate results are obtained in controlled situations.

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