Looking Backwards to the Future: The WHO Haemoglobin Colour Scale

S. Mitchell LEWIS

Department of Haematology, Faculty of Medicine of Imperial College, Hammersmith Hospital, London W12 0NN, UK

ABSTRACT

The Haemoglobin Colour Scale was developed for WHO as a simple, cheap, pocket-sized device for providing a reading of haemoglobin within 1 g/dL of true value. It is intended for the clinician/health worker without easy access to a laboratory, and it thus has an important role in management of anaemia in peripheral health services, especially in under-resourced areas, as well as in antenatal and child health programmes, in screening blood donors and for point-of-care anaemia checks anywhere. An international validation trial and other studies have confirmed its reliabilty when tested against reference haemoglobinometry. It is much more reliable than clinical examination in assessing the severity of anaemia and it has advantages over copper sulphate in blood donor screening.

Key Words: Haemoglobin, WHO scale.

Turk J Haematol 2002;19(2):185-189

Advances in scientific methodology and changes in medical practice generally occur by evolution, with each generation building on a previously established framework. Medical journals have always had an important role in this transfer of knowledge, and the influence of the editors gives them a serious responsibility to their profession. Professor Orhan Ulutin took on this challenge forty years ago when he became editor of the then Istanbul Contributions to Clinical Science, and subsequently relaunched it as the Turkish Journal of Haematology, thus contributing significantly to the development of that speciality in his own country and beyond. This paper illustrates how an abandoned method, published one hundred years ago, has been resurrected by means of modern technology, and developed to meet current needs.

According to the World Health Organization (WHO) 40% of the world's population, two billion people, suffer from anaemia, either primary or secondary to another condition[1]. In many cases their clinical care is managed by health workers who do not have access to laboratory services, and who must thus rely on physical signs alone. For many years WHO was aware of the need for a simple device for diagnosing anaemia-a cheap, robust, reliable method, independent of electricity or battery power supply. There was the obsolete scale to measure haemoglobin as a percent of normal, which was described by Theodor Tallqvist of Finland in 1900[2]. This was based on comparing the colour of a drop of blood on a piece of blotting paper

against the colours of different concentrations of blood on a painted chart, but this had been long since discarded as being totally inaccurate and unreliable. With support of the Clinical Technology Unit at WHO (now Blood Safety and Clinical Technology Department), my colleague Dr. Gordon Stott and I decided to try the same principle, but now using modern sophisticated technology to eradicate the causes of error in the original method.

Instead of crude blotting paper, what was needed was a material with rapid absorbency of the blood drop with immediate loss of sheen and uniform colour spread without interference from fibres of the material. After extensive trials with various materials we identified a specific matrix (Whatman 31ET Chromatography paper) which could be cut into test strips. Using the WHO international haemoglobin reference standard and spectroscopic measurement of absorption at 540 nm, we prepared a set of standardized blood samples with haemoglobin values from 4 to 14 g/dL. The spectral characteristics of the colours produced by these bloods on the selected chromatography paper were identified by computerised analytic spectometry and then by means of modern ink and print technology a colour scale was prepared of shades representing this range. The colours were printed on a neutral card in strips, 40 mm long and 20 mm wide, surrounded by a neutral grey background to avoid visual distraction; the front was varnished (subsequently laminated) to protect the colours while the back was also laminated to allow any traces of blood to be easily wiped off with a damp tissue. In the middle of each colour shade was punched a circular aperture of 8 mm diameter, a size which was found from preliminary studies to be just right to facilitate the comparison of shade to blood spot when the latter is placed behind the scale[3,4]. The haemoglobin colour scale (HCS) is related very distantly to the original Tallqvist scale-in the same way that a modern pneumatic tyre is related to the original iron wheel!

The scale which we chose was comprised of six shades representing a range from 4 to 14 g/dL in 2 g/dL steps; as the intermediate values of 5, 7, 9, 11 and 13 g/dL respectively are easily read between two of the printed colours, the scale is thus capable of reading haemoglobin values to 1 g/dL. As the HCS is intended for the clinician/health worker at point-of-care information, the following clinical categories were proposed:

Hb 12 g/dL and >	Not anaemic
Hb 10-< 12 g/dL	Mild anaemia
Hb 8-< 10 g/dL	Moderate anaemia
Hb 6-< 8 g/dL	Marked anaemia
Hb 4-< 6 g/dL	Severe anaemia
Hb < 4 g/dL	Critical

To validate its performance a preliminary field trial was undertaken with midwives in a rural hospital whilst WHO organized an international trial in a number of health clinics[5]. The results were promising, although the scale required some “fine tuning” of some of the colours, as well as the need for clearly defined Instructions for use[6]. A subsequent trial in Johannesburg, South Africa showed very good comparisons between HCS readings by the clinic staff (nurses, midwives, doctors and technicians) and reference measurements in the hospital laboratory (Table 1)[7]. The results in antenatal clinics showed a high level of accuracy (Table 2).

Comparison of the HCS with clinical features was also studied in some antenatal clinics, and there was no doubt of the greater reliability of the HCS (Table 3)[7]. A similar study in preschool children showed that 85.2% of cases with anaemia (Hb < 11 g/dL) were identified by the HCS and only 19.7% by clinical pallor; of nineteen severely anaemic children (Hb < 7 g/dL) 100% were classified by the HCS and only 61.1% by clinical pallor[8].

The WHO trial included several blood transfusion centres where blood donors were routinely assessed for anaemia by the copper sulphate test[9]. For the validation study each centre was also provided with a calibrated HemoCue haemoglobinometer which served as the reference method. HCS was able to discriminate haemoglobins of less than 12 g/dL from those which were 12 g/dL or higher with an accuracy of 97.5% (Table 4). It was debatable whether the cut-off point for donor detection should have been 12.5 g/dL for women and 13.5 g/dL for men, as these are the most commonly used limits; however, in the UK the National Blood Services now uses 12 and 13 g/dL respectively, and even lower levels have been proposed in some countries[10]. Accordingly, each centre was instructed to use its own customary criteria for identifying the level of haemoglobin (as measured by the HemoCue) at which the donor should be accepted or rejected, while HCS cut-off was set at 12 g/dL. On this basis HCS gave

Table 1. Discrepancies between HCS and reference haemoglobin in 517 cases

Variance from reference	
1 g/dL or less	489= 94.6%
1.1-1.4 g/dL	11= 2.1%
1.5-1.9 g/dL	9= 1.7%
2 g/dL (one colour shade)	8= 1.6%
3 g/dL (two colour shades)	0= 0%

3.7% false results (1.5% false reject; 2.2% false accept) compared to the copper sulphate method by which there were 6.1% false results (5.2% false reject; 0.9% false accept). When the cut-off was reduced to 12 g/dL in all centres, HCS showed 1.6% false reject compared to 5.2% by copper sulphate. Thus, HCS has the advantages over copper sulphate in the significantly lower rejection rate, especially important with the present-day universal shortage of blood donors. Moreover, the method is simple to use, readily available at all times, does not require frequent renewal and is not subject to the rapid deterioration in the copper sulphate solution which occurs in tropical climates as a result of either concentration due to evaporation in hot weather or dilution when humid.

CONCLUSIONS

It can be concluded that the HCS is a useful tool for accurately identifying anaemia and assessing its severity. It does not compete with laboratory-based haemoglobinometry, as it is intended only as a clinical resource where it is less important to obtain a precise measurement of haemoglobin than to decide what clinical action is required. It is simple to use and requires only a very brief training session. It is pocket-size, indepen-

Table 2. Reliability of HCS compared with reference measurements at antenatal clinics (n= 1736)

Hb (g/dL)	12 & >	10 & >	< 10	< 8	< 6
True positive	399	903	709	210	54
True negative	1217	709	903	1482	1675
False positive	80	63	61	21	7
False negative	40	61	63	23	0
Sensitivity %	90.9	93.7	91.8	90.1	100
Specificity %	93.8	91.8	93.7	98.6	99.6
Positive prediction %	83.3	93.5	92.1	90.9	88.5
Negative prediction %	96.8	92.1	93.5	98.5	100
Accuracy %	93.1	92.9	92.9	97.5	99.6

Table 3. Comparison of clinical signs and HCS in 314 cases

Reference Hb	Total no	Clinical signs positive	Anaemia by HCS
12 & > g/dL not anaemic	156	26= 16.6%	5= 3.2%*
10- < 12 g/dL mild anaemia	74	23= 31.1%	50= 67.6%
8- < 10 g/dL moderate anaemia	63	42= 66.6%	61= 96.8%
6- < 8 marked anaemia	18	14= 77.7%	18= 100%
< 10 g/dL	84	59= 70.2 %	83= 98.8%
< 8 g/dL	21	17= 80.9%	21= 100%
< 6 g/dL Severe anaemia	3	3= 100%	3= 100%

* HCS reading indicated only a mild anaemia (10 or 11 g/dL) in the 5 cases

Table 4. Blood donor selection at 12 g/dL

	HCS: Anaemic (< 12 g/dL)	HCS: Not anaemic (□ 12 g/dL)
HemoCue: < 12 g/dL	94 (true neg)	16 (false pos)
HemoCue: □ 12 g/dL	54 (false neg)	2637 (true pos)

Sensitivity 98.0%, specificity 85.5%, accuracy 97.5%.

dent of electricity, and can be used in daylight or in any sort of artificial light. The test is rapid, taking less than one minute. It requires one drop of blood, which can be obtained either by skin puncture or by venesection if blood is being collected for other tests. It is cheap, costing less than two cents (US$ 0.02) per test. Thus, it has an important role in providing access to health technology for peripheral health services in under-resourced areas. Its utility has been demonstrated in general health clinics as well as in antenatal and child health programmes, in deciding when to refer severe anaemia patients for hospital treatment and in the screening of blood donors for anaemia. It will also be an extremely useful tool for point-of-care anaemia checks any-where.

The validation studies described above were carried out with the prototype[3,4]. WHO has now contracted a commercial company (Copack GmbH, Am Knick 9, 22113 Oststeinbek, GERMANY, e-mail: copack@t-online.de) to be the authorized manufacturer of the HCS in accordance with these specifications. To ensure the quality of this manufactured product, the printing of the scale, control of its manufacture and subsequent stability studies are supervised by the WHO Collaborating Centre for Haematology Technology.

REFERENCES

1. World Health Organization 1998 The World Health Report 1998. WHO, Geneva.
2. Tallqvist TW. Ein einfaches verfahren zur directen schätzung der farbestarke des blutes. Zeitshift fur Klinische Medizin 1990;40:137-41.
3. Stott GJ, Lewis SM. A simple and reliable method for estimating haemoglobin. Bulletin of the World Health Organization 1995;73:369-73.
4. Lewis SM, Stott GJ, Wynn KJ. An inexpensive and reliable new haemoglobin colour scale for assessing anaemia. Journal of Clinical Pathology 1998;51:21-4.
5. Münster M, Lewis SM, Erasmus LK, Mendelow BV. Field evaluation of a novel haemoglobin measuring de vice designed for use in rural setting. South African Medical Journal 1997;87:1522-6.
6. Gosling R, Walraven G, Manneh F, Bailey R, Lewis SM. Training health workers to assess anaemia with the WHO haemoglobin colour scale. Tropical Medi-cine and International Health 2000;5:214-21.
7. Ingram CF, Lewis SM. Clinical use of WHO haemoglobin colour scale: Validation and critique. Journal of Clinical Pathology 2000;53:933-7.
8. Montresor A, Albonica M, Khalfan N, Stoltzfus J, Tielsch JM, Chwaya HM, Savioli L, et al. Field trial of a haemoglobin colour scale: An ef-fective tool to detect anaemia in preschool children. Tropical Medicine and International Health 2000;5:129-33.
8. Lewis SM, Emmanuel J. Validity of the haemoglobin colour scale in blood donor screening. Vox Sanguinis 2001;80:28-53.
9. Boulton FE. Threshold concentration of haemoglobin in donor blood. Vox Sanguinis 1999;77:108-9.
10. Garratty G. Contoversies in transfusion medicine. Should donor haemoglobin standards be lowered? Transfusion 1989;29:261-164.

Address for Correspondence:

S. Mitchell LEWIS, MD

Department of Haematology
Faculty of Medicine of Imperial
College of Science Technology and
Medicine The Hammersmith Hospital,
London W12 ONN, UK

e-mail: *smlenl@intonet.co.uk*