THE COLOUR INDEX

ITS SIGNIFICANCE AND LIMITATIONS.

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When the blood count report includes a red cell count and hæmoglobin estimation, it is customary for the laboratory to add an index figure known as the colour index, and in the report this is usually abbreviated to C.I.

This figure, or index, is calculated on the red cell count expressed in millions per cumm., and the hæmoglobin percentage, it gives as an index the hæmoglobin content of a single red blood cell, as compared with the hæmoglobin content of a normal cell.

In theory, the normal figure for colour index should be one; therefore, values below unity indicate that the individual cell contains less hæmoglobin than normal, figures above unity indicate an increase; actually it is impossible for a normal sized red cell to contain more hæmoglobin, in health it is saturated, so an increase can only be obtained when the cells are larger than normal. While the theoretical normal is one, in practice figures from 0.85 to 1.1 are not necessarily abnormal; in fact, a normal colour index is usually slightly less than one.

Calculation of the Index.

In order that the relationship of the red cell count and the hæmoglobin percentage may be expressed as the colour index, it is necessary that they should be expressed in units of the same value, the units employed are "the percentage of normal."

It is customary to report red cell counts as number of cells per cumm. and the hæmoglobin estimation as a certain percentage of a normal standard, together with an indication of the grams per cent. of hæmoglobin represented by this figure.

A figure of 5,000,000 per cumm. red cells has, both on the grounds of convenience and established practice, become accepted as the normal for red cell counts, the percentage of normal, which is the figure wanted for calculating the colour index, is obtained by multiplying the first two figures of the count by two. Thus the percentage of normal of a 5,000,000 count would be $50 \times 2 — 100$.

A hæmoglobin percentage of 100 per cent. with a value of 14.5 grams per cent. hæmoglobin is taken as normal, incidentally it is important to remember that almost every method of hæmoglobin estimation has a different value of grams per cent., represented by 100 per cent., and if this figure differs markedly from the normal of 14.5 a suitable correction factor must be applied to the colour index calculation.

There are two principal methods of hæmoglobin estimation in clinical use in this country, Haldane and Sahli. In Haldane's method 100 per cent. equals 13.8 grams per cent. hæmoglobin and no correction factor is required; but with Sahli's method more care must be taken; most modern instruments are calibrated to the same figure as Haldane, but there are instruments available with much higher values, such as 100 per cent. equals 16.0 grams per cent., and in the original Sahli 100 per cent. equalled 17.3 grams per cent. With these two last figures a correction factor is essential if colour index calculation is to be accurate.

Formula for Colour Index Calculation.

$$\text{Colour index} = \frac{\text{Percentage of hæmoglobin}}{\text{Percentage of red cells}}$$

The percentage of hæmoglobin is calculated as 14.5 grams of hæmoglobin equals 100 per cent., and the percentage of red cells is taken as 5,000,000 per cumm. equals 100 per cent.

Example.

Red cell count 3,500,000 cumm. hæmoglobin 66 per cent. (Haldane scale).

Colour index—Hæmoglobin $\frac{66}{\text{Red cell count } (35 \times 2)\ 70}$ C.I. 0·94.

In other words, to obtain the colour index, double the first two figures of the red cell count and divide into the observed hæmoglobin percentage. It is only possible to take the observed percentage of hæmoglobin when the method of estimation is Haldane, or some other method in which 100 per cent. approximately equals 14.5 grams per cent. In other cases the figure must either be worked out from first principles or more simply converted to the normal scale of 14.5 by means of multiplying the observed percentage by a suitable correction factor.

Hæmoglobin Correction Factor for Colour Index Calculations.

Sahli	100 per cent.—16.0 grams per cent. × 1.1.
Sahli (original method)	100 per cent.—17.3 grams per cent. × 1.2.

These correction factors are not quite correct, but they are sufficiently accurate for the purpose.

Significance and Value of the Colour Index.

Within certain limits, the colour index has great value in the classification of the anæmias, certainly it is an essential preliminary step. The classification of anæmia on the colour index figures divides them into three main groups, called hyperchromic, normochromic and hypochromic.

Hyperchromic anæmias have a colour index greater than one, and indicate that the cell contains more than the normal amount of hæmoglobin. As has already been stated, the normal sized cell is saturated with hæmoglobin, so it can only achieve a higher content by an increase in size. Such cells are called macrocytes and such a change is characteristic of anæmias of the pernicious or macrocyte type. Normochromic anæmias have their cells and hæmoglobin reduced in roughly the same proportion and a colour index in the region of one is maintained; an anæmia, as the result of acute hæmorrhage, would be of this type.

In anæmias of the hypochromic type the colour index is less than one; that is to say, the cells contain less than the normal amount of hæmoglobin. Such a picture is seen in the iron deficiency or microcytic anæmias, in which the hæmoglobin is reduced to a relatively greater extent than the number of red cells. It must be realised that in an anæmia not only can the red cells be reduced in numbers and with them the hæmoglobin percentage, but an alteration in size of cell and content of hæmoglobin may take place.

It is very important that this relationship of red cells to hæmoglobin should be understood, as the colour index is an expression of this ratio.

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