CLINICAL ASSESSMENT OF HAEMOGLOBIN CONCENTRATION

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Some assessment of the patient with regard to the presence or absence of anaemia forms part of every general clinical examination. This may be done by inspection of the conjunctivae, palm creases, oral mucosae, and nail-beds, for the normal pink coloration. Generally a very rough assessment is made into "normal" and "pale," and, if the latter is found, the haemoglobin is more accurately determined. If the patient is thought not to be anaemic it may be thought unnecessary to pursue the evaluation of the haemoglobin by a more accurate method.

The purpose of the present investigation was to determine with what accuracy a haemoglobin percentage could be predicted by clinical examination alone. The investigation was also designed to determine whether inspection of the conjunctivae was more or less accurate than inspection of the palm creases, and whether an overall opinion, which took into account the appearance of the patient as well as the colour of the conjunctivae and palms, was more or less accurate than any individual form of assessment.

Material and Method

Two hundred consecutive new patients attending an out-patient clinic for blood diseases were used for the investigation. The selection for this clinic was made almost entirely by the general practitioners who refer the patients, and only a few patients were referred by other clinicians in the hospital.

The patients were seen independently by two of us (A. S. D. and S. G. M.). An initial assessment of facial colour was

recorded as either normal or pale. The conjunctivae were inspected before the palm creases in the first 100 consecutive patients (C_1 series), and vice versa for the second 100 patients (P_1 series). An estimate of the haemoglobin level in multiples of 5% was recorded in each instance. The palm creases were inspected with the hand held at heart level, and the skin of the palm stretched so that the creases were opened. A final assessment was then made, taking into account the two recorded figures and the skin colour, and a percentage again recorded. These results were compared with the figure obtained by estimation of the haemoglobin concentration in an EEL photoelectric colorimeter, calibrated so that 100% was equal to 14.8 g. of haemoglobin per 100 ml. The accuracy of the colorimeter was checked regularly, using a standard sample of blood of known haemoglobin concentration provided by Messrs. Keeler, Ltd. In most instances capillary blood from a finger-prick was used, but occasionally heparinized venous blood when venepuncture was required for some other reason.

Results

For the purpose of expressing results it was decided that 80% should be taken as a critical figure. This figure was chosen because it was thought that an estimate below 80% would usually be checked by more detailed blood examination and any discrepancy between the estimate and the true figure thus be corrected. If the estimate was below 80% and the true figure above 80%, the error was not important, as it would soon be detected. On the other hand, if the estimate was above 80% and the true figure below it, then the error was serious for obvious reasons.

If there were no errors in the conjunctival (C) or in the palm-crease (P) estimates, the relationship between C, P, and the "true" value (T) would be $C=T$ and $P=T$. The results in each series, however, show that the coefficients of C and P in the regression equations of T on C and of T on P are significantly different from 1. At the lower end of the scale the conjunctival and palm-crease values underestimate the true value—for example, clinical estimation = 40%; true value = 47%—and at the upper end the clinical assessment overestimates on the true value—for example, clinical estimation = 100%; true value = 91%. The regression equation determines mean values of T for given values of C or P, but by the use of the standard error of estimate it is possible to calculate, for a given value of C or P, the probability that an individual patient will have a value of T equal to or less than 80%, as shown in Table I (A. S. D.'s results). Thus, if the conjunctival estimate of an individual patient in the C_1 series is $C=50\%$, there is a probability of 0.99 that T is equal to or less than 80%. This means that on the average 99 patients in every 100 will have a true value of haemoglobin less than or equal to

TABLE I.—Probability of a Haemoglobin Estimate within the Range 30–110% being Equal to or Less than a "True" Value of 80%. Estimates were made after inspection of the Conjunctivae (C) and Palm Crease (P). The Regression Equation for each Series is also Given (see text)

	C_1 Series Conjunctival Estimates (C)	C_1 Series Palm-crease Estimates (P)	P_1 Series Conjunctival Estimates (C)	P_1 Series Palm-crease Estimates (P)	C_1 Series Final Assessment (A)	P_1 Series Final Assessment (A)
Regression equation	$T = 0.74C + 17.27$	$T = 0.76P + 14.25$	$T = 0.71C + 22.76$	$T = 0.71P + 18.07$	$T = 0.76A + 15.05$	$T = 0.71A + 22.54$
Percentage Haemoglobin Estimated	Probability	Probability	Probability	Probability	Probability	Probability
	$T \leq 80\%$	$T \leq 80\%$	$T \leq 80\%$	$T \leq 80\%$	$T \leq 80\%$	$T \leq 80\%$
30	0.9998	0.999	0.9986	0.9978	0.9998	0.9987
40	0.998	0.995	0.992	0.992	0.998	0.993
50	0.990	0.980	0.984	0.972	0.990	0.970
60	0.951	0.933	0.939	0.922	0.951	0.901
70	0.839	0.824	0.831	0.816	0.841	0.752
80	0.622	0.637	0.637	0.648	0.630	0.528
90	0.356	0.409	0.291	0.440	0.367	0.298
100	0.147	0.209	0.125	0.251	0.159	0.129
110	0.045	0.085	0.042	0.119	0.050	0.043

C_1 Series = 100 patients in whom conjunctival estimate was made before palm-crease estimate. P_1 Series = 100 patients in whom palm-crease estimate was made before conjunctival estimate. C = Conjunctival estimate of Hb%. P = Palm estimate of Hb%. A = Final assessment of Hb%. T = "True" value of Hb%.

80%. In the same series, for an assessment of 60% there would be on the average 95% of patients with a true value of haemoglobin less than or equal to 80%. At the other end of the scale, if $C=110\%$ there would be on the average only 4 to 5% of patients with a true haemoglobin less than or equal to 80%. The results in Table I which occur beneath the heavy line drawn at 80% indicate the liability to serious error in each series of estimations.

In this paper only the results of one observer (A. S. D.) have been given. We have felt justified in this, as the differences between the results of S. G. M. and A. S. D. were surprisingly small, and the conclusions which we draw from this investigation are as true for the results of the one as for the other. The results of S. G. M. have therefore been omitted in order to simplify the paper.

Table II shows the correlation between skin colour and true haemoglobin percentage. The results illustrate the fallibility of the skin as an index of haemoglobin concentra-

TABLE II.—Distribution of Observations According to Skin Colour and "True" Haemoglobin Percentage

	Skin Normal	Skin Pale	Total
True Hb > 80%	72	34	106
" Hb < 80%	28	66	94
Total	100	100	200

tion. Twenty-eight per cent. of patients with a normal skin colour had haemoglobin values less than 80%, while 34% of patients with pale faces had, in fact, a haemoglobin of 80% or more.

Discussion

It is valuable to know the limitations of the clinical and laboratory techniques used in everyday medical practice. Much has been written about the errors of laboratory methods, but less about the errors of clinical examination, largely because of the difficulties in equating a clinical sign with a suitable laboratory procedure. The present investigation has been concerned with the clinical assessment of haemoglobin concentration, and this is fortunately one of the few aspects of clinical examination which can readily be compared by a laboratory method.

There is an unpredictable personal factor in the determination of many physical signs. In the present investigation it was surprising to find so close an agreement between the results obtained by two observers independently. One of us tended to estimate slightly higher than the other at certain times, but there was no statistical difference between the regression coefficients in any of the series.

The most accurate clinical assessment of haemoglobin percentage was made by inspection of the conjunctivae in the series of 100 patients in whom the conjunctivae were inspected before the palmar creases (C_1 series). The final assessment in this series, which took into account the palmar creases and facial colour as well as the conjunctivae, was almost identical with the conjunctival assessment alone, so that it would appear that inspection of the palmar creases and skin colour has nothing to add to the accuracy of conjunctival inspection. In an occasional patient chronic conjunctivitis has led to an erroneously high haemoglobin assessment being made, and this assessment has been corrected by inspection of the palm creases. Conversely, interpretation of the palmar creases was difficult in many patients. The palm crease was found not infrequently to have a brown pigmentation, which made estimation of the haemoglobin unreliable. This was particularly common amongst housewives, possibly as a consequence of the use of washing soda and detergents. Thickening and hardening of the skin of the palm from manual work also produced a similar problem.

Wintrobe (1950) has stated, and Silverman (1954) has confirmed, that a colourless palm crease is indicative of a haemoglobin of under 50%. We have also found this to be

true. At levels between 55 and 75% we found that the palm creases often had lost the normal bright red colour and were instead a brownish red.

The results which we have obtained, and which are set out in Table I, show the liability to "serious error" as previously defined and the degree of accuracy of estimates from 30 to 80%. Serious errors were fewer with conjunctival estimates than with palm-crease estimates in both the C_1 and P_1 series. It can be seen from Table I that for conjunctival estimates of 90% haemoglobin on the average 29-36% of patients had, in fact, a true haemoglobin value equal to or less than 80%—that is, the liability to serious error was 29-36%. The figures for estimates of 100% and 110% haemoglobin in the same series were 12-15% and 4-5% respectively. Compared with these results the estimates for the lower haemoglobin estimations were much more favourable. With the same series as before, for an estimated haemoglobin value of 60% there were, on the average, 94-95% of patients with a true haemoglobin value equal to or less than 80%. Corresponding figures for estimates of 50% and 40% haemoglobin were 98-99% and 99% respectively.

It is concluded from these results that the clinical assessment of anaemia is a reasonably accurate procedure when estimates of haemoglobin are of 60% or below, but that it is unreliable when the haemoglobin is estimated as above 60%, and a more accurate method of haemoglobin evaluation is then required for the diagnosis of anaemia.

Summary

An investigation was carried out on 200 out-patients attending a haematological clinic to determine the value of a clinical assessment of haemoglobin concentration.

Estimations of haemoglobin were made independently by two observers after inspection of the conjunctivae and palmar creases. The facial colour was also recorded as normal or pale. A final assessment was made, utilizing these three results. The figures recorded by the two observers showed close agreement.

The estimates were compared with readings obtained by measuring haemoglobin concentration in a photoelectric colorimeter, and showed that the liability to error was small with clinical estimates of haemoglobin at 50% or less, that at 60% the error was appreciable, and that above 60% estimates were so often erroneous that they could not be relied upon in the diagnosis of anaemia.

It was also concluded that, with few exceptions, conjunctival inspection gave a more reliable estimate of haemoglobin than inspection of the palmar creases.

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The quality of the milk analysed during the second quarter of 1957 is discussed in the latest report of the Birmingham city analyst. The average composition of the milk submitted for analysis—8.79% solids-not-fat, and 3.48% fat, a total of 12.27% solids—was stated as being exceptionally high for the time of year, and an improvement on the two previous years. Of the samples analysed 88 did not conform to the required standards: 16 were deficient in solids-not-fat, 69 in fat, and 3 in both constituents. The preponderance of samples low in fat content over those deficient in non-fatty solids was thought to be connected with the change from winter stall-feeding to spring pasturing.