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CONTENTS

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FACTORS AFFECTING THE OUTCOME OF
TREATMENT OF PULMONARY TUBERCULOSIS
IN SUB-OPTIMAL CONDITIONS:

An 18-month Follow-up of 224 Patients

By

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Iron Deficiency Anaemia in Rhodesian Africans

BY

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It has been shown that the incidence of siderosis in Rhodesian Africans is high (Gelfand, 1955; Buchanan, 1966; Buchanan, 1967). In view of this it would be expected that iron deficiency anaemia would be uncommon in these people, yet it has been said that, on the contrary, it is fairly common. The following investigation was undertaken in an attempt to clarify the position.

MATERIAL AND METHODS

The subjects chosen for the investigation were African patients and normal relatives coming to the outpatients department of Harare hospital. Seriously ill patients and patients with raised temperatures or other evidence of acute inflammation were excluded because of depression of serum iron in these conditions.

The commonest complaints responsible for the patients seeking medical advice were related to urinary bilharziasis, backache, muscle and joint pains, vague abdominal pains and skin diseases. In female patients, as well as the above, many complained of dysmenorrhoea or infertility. Subjects with obvious blood loss, such as menorrhagia or incomplete abortion, were also excluded. Approximately 50 per cent. of the women were mothers bringing sick children and were not themselves indisposed.

Cases coming to the outpatients department of Harare hospital appear to be fairly representative of the African population of Salisbury and its immediate environs. It was felt that though such a group might not reflect with complete accuracy the incidence of anaemia in the African population as a whole, any error would be to overestimate the incidence rather than underestimate it.

Approximately 30 patients of each sex were taken from each decade, starting at the second one. Owing to the small numbers of older women coming to the hospital, only 30 females were taken in the sixth and seventh decades together. In all, 185 males and 156 females were examined.

Twenty ml. of blood were withdrawn from an arm vein into a disposable polythene syringe. A small quantity was transferred into a sequestrine tube for estimation of haemoglobin and for the blood film; the remainder was placed in iron-free glass containers, where the serum was allowed to

separate. All specimens were taken between 8.30 a.m. and 10 a.m.

The blood slides were stained with Leishman's stain and the haemoglobin estimated by the cyanmethaemoglobin method (Dacie and Lewis, 1966). The serum iron (S.I.) was estimated by the method of Bothwell and Mallet (1955) and the unsaturated iron-binding capacity (U.I.B.C.) by the method of Bothwell *et al.* (1959).

In view of the fact that no reliable values are available for the level of haemoglobin in completely healthy Africans, it was decided to use de Gruchy's criteria (de Gruchy, 1959), viz., to define as anaemic adult males whose haemoglobin was below 13.5 g./100 ml. and adult females whose haemoglobin was below 11.5 g./100 ml. Values for children under 16 years were compared with the normals for the same age given by de Gruchy. In normal subjects S.I. ranges from 60 to 200 $\mu\text{g.}/100$ ml., T.I.B.C. ranges from 250 to 400 $\mu\text{g.}/100$ ml., and percentage saturation transferrin from 35 to 40 (Bothwell and Finch, 1962).

RESULTS

The average serum iron, total iron-binding capacity, percentage saturation of transferrin and haemoglobin values and their ranges are seen in Table I.

The number of anaemic subjects in each decade is shown in Table II. Also shown in this table is the number of subjects suffering from anaemia whose S.I. was less than 60 $\mu\text{g.}/100$ ml. Some further details of the anaemic males and females with low S.I. values are seen in Tables III and IV respectively.

Fifty-four (29.2 per cent.) males showed some degree of anaemia and, as Table II shows, the incidence of anaemia rose with age. Twelve of these anaemic males—i.e., 6.5 per cent. of all the males examined—had S.I. value of less than 60 $\mu\text{g.}/100$ ml. Eleven of the 12 also showed some decrease in percentage saturation of transferrin. In all but five of the 12 the T.I.B.C. was less than 300 $\mu\text{g.}/100$ ml., so it is unlikely that they were iron deficient as the T.I.B.C. is raised in that condition (Bothwell and Finch, 1962). In five, blood films revealed slight to moderate polychromasia and some anisocytosis of the erythrocytes. No appreciable hypochromia was seen in any of the male blood films examined.

There were therefore five (2.7 per cent.) males with lowered haemoglobin, S.I. and percentage saturation of transferrin and T.I.B.C. values in the upper range of normal or frankly raised. These subjects were almost certainly suffering

Table 1
MEAN BLOOD VALUES, STANDARD DEVIATIONS AND RANGES OF 341 AFRICAN SUBJECTS

Age Group	MALES				
	No.	Serum Iron $\mu\text{g.}/100\text{ ml.}$	Total Iron Binding Capacity $\mu\text{g.}/100\text{ ml.}$	Percentage Saturation Transferrin	Haemoglobin $\text{g.}/100\text{ ml.}$
10-19	30	Mean 100 ± 36.5 Range 40-189	398 ± 60.0 323-568	26 ± 9.3 8-46	13.2 ± 1.19 11.2-16.0
20-29	31	Mean 126 ± 35.5 Range 65-204	358 ± 43.3 266-462	36 ± 12.2 16-66	14.9 ± 1.0 12.7-16.8
30-39	32	Mean 110 ± 44.7 Range 49-218	347 ± 50.7 246-456	32 ± 16.7 11-80	14.7 ± 1.5 10.8-17.2
40-49	31	Mean 112 ± 39.1 Range 33-231	313 ± 54.5 223-447	37 ± 18.2 11-86	14.0 ± 2.7 6.3-17.2
50-59	31	Mean 109 ± 46.1 Range 38-228	329 ± 53.7 213-434	34 ± 14.8 10-68	13.9 ± 1.7 10.4-18.6
60 +	30	Mean 113 ± 54.8 Range 34-258	325 ± 54.3 196-445	36 ± 17.6 12-84	13.3 ± 1.5 10.8-16.0
TOTAL	185	Mean 112 Range 33-258	345 196-568	34 8-86	14 6.3-18.6
Age Group	FEMALES				
	No.	Serum Iron $\mu\text{g.}/100\text{ ml.}$	Total Iron Binding Capacity $\mu\text{g.}/100\text{ ml.}$	Percentage Saturation Transferrin	Haemoglobin $\text{g.}/100\text{ ml.}$
10-19	31	Mean 94 ± 30.4 Range 40-166	403 ± 68.3 274-555	24 ± 7.29 10-40	11.8 ± 1.3 8.9-14.5
20-29	32	Mean 110 ± 30.9 Range 58-186	393 ± 54.8 253-480	29 ± 9.4 14-53	12.4 ± 0.9 10.4-14.8
30-39	31	Mean 88 ± 28.0 Range 24-143	390 ± 73.7 290-593	23 ± 9.7 5-45	12.1 ± 1.5 7.8-14.1
40-49	31	Mean 86 ± 28.9 Range 28-147	390 ± 65.4 291-571	23 ± 10.7 5-49	11.9 ± 2.0 6.3-14.5
50-59	21	Mean 115 ± 65.1 Range 26-272	362 ± 89.5 225-563	33 ± 21.2 5-85	12.2 ± 2.3 5.2-13.8
60 +	10	Mean 96 ± 59.5 Range 60-243	323 ± 44.2 265-401	31 ± 23.4 15-87	12.1 ± 1.69 8.2-13.4
TOTAL	156	Mean 97 Range 24-272	367 225-593	26 5-87	12.1 5.2-14.8

from some degree of iron deficiency anaemia, though in most cases this was mild.

In 17 (9.2 per cent.) males the percentage saturation of transferrin was greater than 60 (range 62-86). See Table V. In these subjects the serum iron values were normal or moderately raised, ranging from 162 to 258 $\mu\text{g./100 ml.}$, while their T.I.B.C. values were normal or slightly lowered, ranging from 228 to 349 $\mu\text{g./100 ml.}$ Five of these 17 males had haemoglobin values

of less than 13.5 g./100 ml. (range 12.7 to 13.4 g./100 ml.). No significant abnormalities were seen in any of their blood films. None of these patients had jaundice, palpable livers or ascites at the time they were seen, and unfortunately it was impossible to recall them for further investigation.

Thirty-four (21.8 per cent.) females were anaemic; 14 of these (9.0 per cent.) had S.I. values of less than 60 $\mu\text{g./100 ml.}$ In 13 of the

Table II
INCIDENCE OF ANAEMIA IN EACH DECADE

Age Group	MALES				
	No. of Cases	Anaemics		Anaemics with S.I. Less than 60 $\mu\text{g./100 ml.}$	
		No.	Percentage of Total	No.	Percentage of Total
10-19	30	5	16.6	0	0
20-29	31	3	9.7	0	0
30-39	32	5	15.6	1	3.2
40-49	31	12	38.7	3	9.7
50-59	31	12	38.7	3	9.7
60 +	30	17	56.6	5	16.7
TOTAL	185	54	29.2	12	6.5
Age Group	FEMALES				
	No. of Cases	Anaemics		Anaemics with S.I. Less than 60 $\mu\text{g./100 ml.}$	
		No.	Percentage of Total	No.	Percentage of Total
10-19	31	9	29	2	6.5
20-29	32	6	18.8	0	0
30-39	31	5	16.1	4	12.9
40-49	31	8	24.2	5	16.2
50-59	21	4	19.1	3	14.2
60 +	10	2	20	0	0
TOTAL	156	34	21.8	14	9.0

Table III
ANAEMIC MALES WITH SERUM IRON LESS THAN 60 $\mu\text{g./100 ml.}$

Age	Hb	Serum Iron	T.I.B.C.	Percentage Saturation	Blood Film
30	11.2	33	289	11	RBCs normochromic and normocytic.
45	8.6	41	223	18	Slight anisocytosis—normochromic.
48	6.3	33	258	13	Moderate polychromasia and anisocytosis.
48	13.4	51	447	11	RBCs normochromic and normocytic.
52	12.7	42	271	16	RBCs normochromic and normocytic.
51	10.4	38	395	10	Moderate polychromasia.
55	12.7	55	434	13	Slight polychromasia and anisocytosis.
65	12.3	49	369	13	RBCs normochromic and normocytic.
60	12.7	51	361	14	RBCs normochromic and normocytic.
60	11.5	47	196	24	RBCs normochromic and normocytic.
60	10.8	35	256	14	Slight polychromasia.
65	12.7	34	293	12	RBCs normochromic and normocytic.

Table IV
ANAEMIC FEMALES WITH SERUM IRON VALUES LESS THAN 60 $\mu\text{g./100 ml.}$

Age	Hb	Serum Iron	T.I.B.C.	Percentage Saturation	Blood Film
13	9.3	44	443	10	Moderate ring staining.
15	10.4	44	436	10	Moderate polychromasia.
30	10.8	59	529	11	RBCs normochromic and normocytic.
30	9.3	40	593	7	Slight ring staining, polychromasia and anisocytosis.
33	10.0	24	481	5	Moderate polychromasia.
35	7.8	28	415	7	Moderate polychromasia.
45	9.1	28	561	5	Moderate polychromasia.
42	8.9	30	494	6	Slight anisocytosis and moderate polychromasia.
40	8.6	39	493	8	Marked polychromasia.
40	7.4	28	337	8	Moderate ring staining, target cells and polychromasia.
44	7.8	35	431	8	Slight ring staining and anisocytosis.
50	5.2	26	563	5	Marked ring staining, anisocytosis and moderate polychromasia.
50	11.2	27	294	9	Slight polychromasia.
50	11.2	55	358	15	RBCs normochromic and normocytic.

14 with lowered S.I. the percentage saturation of transferrin was lowered, the T.I.B.C. was normal or raised and blood films showed hypochromia, polychromasia and some anisocytosis. That is, 8.3 per cent. females appeared to be suffering from iron deficiency anaemia, some of a moderately severe degree.

The percentage saturation of transferrin was greater than 60 in two post-menopausal women, as shown in Table V. In both cases the serum iron values were raised and the T.I.B.C. lowered. No significant abnormalities were seen in the blood film of either.

DISCUSSION

The incidence of anaemia in males in this series was 29.2 per cent. It appears likely that in most cases the anaemia was not due to iron

deficiency, as the S.I. and percentage saturation of transferrin were seldom lowered. The incidence of iron deficiency anaemia judged on the criteria of lowered haemoglobin, S.I. and percentage saturation accompanied by raised T.I.B.C. was 2.7 per cent. In no case was this severe.

This incidence of iron deficiency anaemia is low compared with a European population in the same economic group in which iron deficiency is the commonest cause of anaemia (de Gruchy, 1964). Nevertheless, it is perhaps rather higher than one would expect in a population in which 69 per cent. males have stainable iron in their livers (Buchanan, 1967). It also appears to be higher than that found in the South African Bantu, where hypochromic anaemia is extremely rare (Gerritsen and Walker, 1953).

Table V

SUBJECTS WITH TRANSFERRIN SATURATION OF GREATER THAN 60 PER CENT.

	Years of Age	g./100 ml. Hb.	μ g./100 ml. Serum Iron	μ g./100 ml. U.I.B.C.	μ g./100 ml. T.I.B.C.	Percentage Saturation
MALES	23	14.8	211	110	321	66
	32	15.6	218	131	349	62
	35	10.8	204	52	256	80
	45	14.5	231	38	269	86
	45	14.8	194	106	300	65
	45	13.0	162	66	228	71
	45	14.1	186	65	251	74
	50	14.0	172	69	241	71
	52	14.1	210	99	309	68
	52	15.2	228	133	361	63
	55	14.8	190	103	293	65
	55	13.0	204	94	298	68
	65	13.4	206	121	327	63
	65	12.7	182	94	276	66
	65	14.5	238	110	348	68
	70	16.0	202	40	242	84
70	14.8	258	53	311	83	
FEMALES	52	13.0	272	47	319	85
	60	13.0	243	38	281	87

Anaemia in general was slightly less common in females (21.8 per cent.) than in males, but there was a higher percentage (8.3) with iron deficiency anaemia and the degree of anaemia was more marked than in the males. As in the case of the males, this incidence of iron deficiency anaemia seems rather high, as 53 per cent. African females in this area have stainable iron in their livers (Buchanan, 1967). On the other hand, in the South African Bantu female with a similar incidence of siderosis it has been shown that the usual cause of anaemia in early pregnancy is iron deficiency (Turchetti *et al.*, 1966). It was suggested by Turchetti *et al.* that the relatively high incidence of iron deficiency anaemia in their cases might be explained by the fact that the incidence of siderosis is low in the young women included in their study, though it is high in older women. As the frequency of siderosis in Rhodesian African women varies with age in the same way (Buchanan, 1967), this could account to some extent for the iron deficiency anaemia found in females in this study.

The anaemia, other than that due to iron deficiency (26.5 per cent. in males and 13.5 per cent. in females), found in the subjects examined might have been nutritional or due to chronic renal or chronic liver disease, among other causes. Though it might partly be nutritional in origin, this would not account for the difference in frequency between the sexes because, broadly speaking, male Africans in Rhodesia have a better diet than females. The same is true of chronic renal disease, which occurs about as frequently in females as males. Cirrhosis of the liver, on the other hand, is more than twice as common in males as females in this population (Buchanan, 1967). Anaemia is said to occur in about two-thirds of cases of cirrhosis of liver (de Gruchy, 1964). If this anaemia were a result of cirrhosis it would also explain the higher incidence in the older age groups when the incidence of cirrhosis is highest.

The S.I., T.I.B.C. and percentage saturation of transferrin in males was similar to that found by Gelfand in his series of healthy male Africans in Salisbury (Carr and Gelfand, 1961) and to the S.I. and percentage saturation values found by Wainwright (1957) in Durban. The T.I.B.C. values, however, found by Wainwright were appreciably lower than found in this study. In both males and females all mean values were lower than those found by Gerritsen and Walker (1953) in the Johannesburg area. These authors also found that in a number of tribes, including people from Nyasaland (now Malawi), the aver-

age S.I. and T.I.B.C. values were considerably raised. None of such cases was found in the present series, which included 40 subjects (29 males and 11 females) from Malawi. It may be of some significance that most of these people of Malawi origin had lived in Rhodesia for a number of years, whereas those examined by Gerritsen and Walker were newly arrived in Johannesburg from Malawi.

It is probable that the 17 men and two women with raised S.I. and percentage saturation values had siderosis and that most had cirrhosis, though this was not diagnosed clinically. It is probable also that the type of siderosis was that in which iron deposits are widespread in epithelial tissues and is indistinguishable histologically from idiopathic haemochromatosis. Such a type of siderosis has been shown to occur in South Africa (Isaacson *et al.*, 1961; Bradlow *et al.*, 1960) and Rhodesia (Buchanan, 1967) and is usually associated with high percentage saturation of transferrin.

SUMMARY

The incidence of anaemia in 185 males and 156 female African outpatients attending Harare hospital was investigated. Iron deficiency anaemia was found in 2.7 per cent. males and 8.3 per cent. females. Anaemia due to other causes was found in 26.5 per cent. males and 13.5 per cent. females. The probable causes of this anaemia are discussed.

Seventeen men and two women had raised S.I. and percentage saturation of transferrin and were probably suffering from siderosis with widespread epithelial deposits of iron.

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