PORPHYRIN METABOLISM AND LIVER FUNCTION IN THE BANTU

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Impaired liver function is common among Bantus. Of 1,102 routine medical and surgical patients of all ages and both sexes examined at the Baragwanath Hospital, Johannesburg, before June 1951, 85·4% showed a reversal of the albumin/globulin ratio, with the use of a biuret method of Wolfsohn *et al.*[1] Many of these patients, with no history of jaundice or liver disease, showed gross abnormalities of 'liver function' tests as assessed by the thymol turbidity and flocculation tests and the Takata Ara reaction. In 1950 Bersohn[2] determined the serum proteins of 100 apparently healthy African males, using a micro-Kjeldahl method.[3] These subjects were drawn from the personnel of the South African Institute for Medical Research, the Johannesburg General Hospital, and the Witwatersrand gold mines. Of these apparently normal individuals 69% showed a reversal of the albumin/globulin ratio. It is generally considered that impaired liver function is attributable to the deficient diets so commonly consumed by the Bantu; syphilis and genetic factors are probably not involved.[4]

Increased excretion of porphyrin in the urine is a rather common finding in the Bantu. Using a sensitive qualitative method for the detection of urinary coproporphyrin, Mentz[5] calculated that positive tests were obtained in 65% of random Bantus and only 15% of Europeans; these figures included tests on normal and hospitalized (non-porphyric) individuals.

The excretion of excessive amounts of porphyrin is common in porphyria. Urinary excretion is also increased, although to a lesser extent, in liver disease (e.g. cirrhosis and hepatitis[6-15] and liver damage due to cardiac failure[16] or pregnancy toxaemia[17, 18]), in vitamin deficiencies (e.g. pellagra[16, 19]), during recovery of the bone marrow after haemorrhage,[20] in pernicious anaemia,[21-28] in pyrexial conditions,[14, 23, 29-31] and after sulphonal, veronal or lead poisoning.[16, 32-34] It was the object of this investigation to ascertain whether the defect in porphyrin metabolism which is commonly found in the Bantu could be ascribed to impaired liver function.

METHODS

(*A*) *Porphyrins*

1. *Urine.* (*a*) Coproporphyrin was extracted quantitatively with ether after acidification with glacial acetic acid. The extracts were washed with an alcoholic iodine solution to oxidize porphyrinogen to porphyrin. From the ether solution porphyrin was extracted into hydrochloric acid and estimated colorimetrically. (*b*) Uroporphyrin was extracted with ethyl acetate-amyl alcohol after the urine was buffered to pH 3·0 - 3·2. The porphyrin-containing organic layer was washed with iodine solution and then extracted with hydrochloric acid.

2. *Faeces.* Proto- and coproporphyrin were extracted from a weighed amount of faeces with ether after acidification with acetic acid. The extracts were again oxidized with iodine solution. Coproporphyrin was then extracted with 0·1N HCl and 'protoporphyrin' with 1·5N HCl. The latter solution

undoubtedly contained several prophyrins, but this mixture is here referred to as 'protoporphyrin'. The dry weight of the specimens was estimated and all values were expressed as micrograms per gram of dry faeces.

3. *Colorimetric estimations.* The methods used were similar to those of Rimington *et al.*[35, 36] The optical densities of the HCl extracts were read at 430 mμ and 380mμ and at the peaks of the Soret bands, which differ slightly for the various porphyrins, in the region of approximately 401 - 405 mμ. In the calculations the following extinction coefficients were used:

for coproporphyrin[37]: $E^{1\%}_{1\,cm.} = 8,100$

uroporphyrin[35]: $E^{1\%}_{1\,cm.} = 6,517$

protoporphyrin[38]: $E^{1\%}_{1\,cm.} = 4,890$

4. *Porphobilinogen.* The Watson and Schwartz procedure[39] was used.

(B) Liver Function Tests

The following techniques were used: (1) Thymol turbidity – Maclagan, 1944.[40-41] (2) Thymol flocculation – Neefe and Reinhold, 1946.[42] (3) Colloidal red test – Ducci, 1947.[43] (4) Cephalin – cholesterol flocculation – Hanger, 1939.[44] (5) Takata-Ara reaction – Ucko, 1936.[45] (6) Zinc sulphate turbidity – Kunkel, 1948.[46-47] (7) Alkaline phosphatase activity – King and Armstrong, 1956.[48-49] (8) Van den Bergh reaction.[41] (9) Total bilirubin – Malloy and Evelyn, 1937.[50] (10) Serum proteins – de la Huerga and Popper, 1950.[41, 51] (11) Serum cholinesterase activity – Michel, 1949.[52] (12) Total urobilinogen – Watson, 1936.[53]

(C) Other Tests

The following techniques were used: (1) Total creatinine in urine—Jaffe reaction.[41] (2) Occult blood in faeces—o-tolidine and amidopyrin tests.[54]

EXCRETION OF PORPHYRIN AND UROBILINOGEN IN URINE OF NORMAL INDIVIDUALS

In a series of 12 normal Europeans and 20 normal Bantus one of us (H.E.A.M.) found the highest excretion of coproporphyrin in urine, according to the method used, to be 85μg. in 24 hours or 75 μg. per g. of creatinine and 111 μg. in 24 hours or 99 μg. per g. of creatinine respectively.[5] No uroporphyrin was detected in any of these individuals.

According to Watson[53] and Reinhold[55] normal individuals excrete on the average 0·64 mg. of urobilinogen in 24 hours, while only a small percentage of normal urines contains more than 1·0 mg. It can therefore be assumed that the excretion of more than 1·0 mg. per g. of creatinine is abnormal.

RESULTS

Porphyrin and Urobilinogen in Urine of European and Bantu Patients

The urines of 7 European and 14 Bantu patients chosen at random were examined. The results are given in Tables I and II.

In this experiment only morning specimens of urine could be obtained. Total creatinine was therefore determined and the porphyrin and urobilinogen results expressed in terms of 1 g. creatinine.

The excretion of urobilinogen and porphyrin was normal in 6 out of the 7 Europeans examined. In patient 7 the excretion of both was highly increased; this patient suffered from severe hepatic disease. Patients 1 and 5 were diagnosed clinically as mild cases of hepatitis but, judging from their urobilinogen excretion, there was probably no severe hepatic

TABLE I. EXCRETION OF PORPHYRIN AND UROBILINOGEN IN MORNING URINE OF EUROPEAN PATIENTS

Patient	*Volume (ml.)*	*Creatinine (mg.)*	*Coproporphyrin (μg./vol.)*	*Coproporphyrin (μg./g. creatinine)*	*Urobilinogen (mg./vol.)*	*Urobilinogen (mg./g. creatinine)*
1	250	200	8	39	0·087	0·44
2	250	190	9	47	0·075	0·08
3	160	160	9	59	0·007	0·04
4	250	230	14	61	0·040	0·17
5	205	110	7	65	0·012	0·11
6	250	170	14	84	0·02	0·12
7	250	310	77	248	2·25	7·25

TABLE II. EXCRETION OF PORPHYRIN AND UROBILINOGEN IN MORNING URINE OF BANTU PATIENTS

Patient	*Volume (ml.)*	*Creatinine (mg.)*	*Coproporphyrin (μg./vol.)*	*Coproporphyrin (μg./g. creatinine)*	*Urobilinogen (mg./vol.)*	*Urobilinogen (mg./g. creatinine)*
8	220	211	2	11	0·13	0·060
9	250	113	3	22	0·034	0·210
10	200	200	5	23	0·080	0·40
11	170	300	10	34	0·160	0·540
12	130	100	4	35	0·35	3·50
13	200	300	12	39	0·024	0·080
14	250	450	18	40	0·054	0·120
15	200	100	7	66	0·015	0·150
16	170	80	11	133	1·00	12·00
17	190	76	14	185	0·20	2·60
18	190	110	28	250	0·41	3·70
19	190	110	28	255	6·90	62·70
20	250	190	50	265	0·76	4·00
21	160	90	29	322	0·14	1·60

TABLE III. VARIATION IN EXCRETION OF PORPHYRIN AND UROBILINOGEN IN BANTU PATIENTS

Patient	*Date*	*Volume (ml.)*	*Creatinine (mg.)*	*Coproporphyrin (μg./vol.)*	*Coproporphyrin (μg./g. creatinine)*	*Urobilinogen (mg./vol.)*	*Urobilinogen (mg./g. creatinine)*
22	21·3	250	183	15	86	0·075	0·410
	11·4	190	110	28	250	0·410	3·70
	18·4	250	185	19	104	0·090	0·50
	25·4	230	129	30	233	0·050	0·38
23	11·4	190	140	20	143	0·28	2·0
	15·4	250	190	50	265	0·76	4·0
	18·4	250	100	18	180	0·287	2·87
	25·4	250	170	23	133	0·10	0·64
24	11·4	190	76	14	185	0·20	2·6
	15·4	180	116	22	193	0·24	2·1

dysfunction. In the Bantu patients the excretion of porphyrin was normal in nearly all cases where urobilinogen excretion was normal; only in patient 12 was the urobilinogen excretion raised while that of porphyrin was normal. In all the other patients an increased porphyrin excretion coincided with a rise in urobilinogen excretion. The type of porphyrin excreted in all cases was coproporphyrin; uroporphyrin was not detected.

Variation in the Excretion of Porphyrin and Urobilinogen

The excretion of porphyrin and urobilinogen was followed in 3 Bantu patients with intervals of a few days between determinations. Only morning urines could be obtained, and results were therefore again expressed in terms of 1 g. creatinine. The results are given in Table III.

From these results it can be seen that a normal excretion of porphyrin is sometimes followed by an abnormally high excretion within a few days. Vannotti *et al.*[16] also found the excretion of urinary coproporphyrin to vary in liver disease.

In all 3 patients only coproporphyrin was found; uroporphyrin was not detected. A definite correlation existed between the excretion of coproporphyrin and that of urobilinogen—when one was increased, the other was also increased. This was the case especially in patient 22, in whom the excretion of porphyrin and urobilinogen varied from normal to abnormally high levels.

Porphyrins in Urine and Faeces and Liver Function Tests in European and Bantu Patients

For this experiment complete 24-hour urine specimens were collected at random from 11 European and 18 Bantu patients for the estimation of porphyrins and urobilinogen. During the collection period blood was collected from most patients for liver function tests and faeces for porphyrin estimation. The results are given in Tables IV and V.

Europeans

Porphyrin excretion was normal in 7 patients (nos. 25–31). The urine-faeces porphyrin ratio in these was from 1·5 : 1 to 1 : 3, according to the basis on which the ratio was determined, i.e. μg. per g. dry weight for faeces and μg. per g. of creatinine for urine.

Only in patient 27 were liver function tests definitely abnormal while the excretion of porphyrin and urobilinogen in urine and the urine-faeces porphyrin ratio were normal. Patient 29 showed evidence of only minimal hepatic dysfunction.

Patient 32 showed normal liver function tests, normal excretion of porphyrins in urine and faeces as well as normal urobilinogen excretion, but because of the very low faecal porphyrin excretion, the urine-faeces porphyrin ratio was increased.

In patient 33 porphyrin excretion in the urine was not excessively high, but high-normal. The urine-faeces porphyrin ratio and liver function tests were, however, abnormal.

In patients 34 and 35 porphyrin in the urine was increased while the urine-faeces porphyrin ratio and liver function tests were abnormal. The excretion of urobilinogen was increased in 34 but not in 35.

Uroporphyrin was not detected in any of these patients.

Bantus

In the 10 patients 36 - 45 excretion of porphyrin in urine was normal. The excretion of urobilinogen was increased in 43 and 44 and the urine-faeces prophyrin ratio was abnormal in 37, 40, 43 and 45. Normal liver function tests were obtained in 36 only.

Patient 46 was regarded as a border-line case. The excretion of porphyrin in urine was high-normal, that of urobilinogen normal, but the urine-faeces porphyrin ratio was abnormal. Unfortunately, liver function tests could not be done on this patient.

In the 7 patients 47 - 53 porphyrin excretion in urine was increased. The excretion of urobilinogen was also increased except in 50 and 51. Liver function tests and the urine-faeces porphyrin ratio were abnormal. Uroporphyrin was not detected in any of these patients.

Comparison of Europeans with Bantus

A marked difference in occult blood results was found between Europeans and Bantus. Strongly positive results were much commoner among the European patients, findings which make interpretation of the urine-faeces porphyrin ratio difficult. Brugsch[56] analysed faeces of normal individuals and tabulated the results according to the benzidine reactions given by the specimens. From these tables Barnes[57] calculated the amounts of ether-soluble copro- and non-coproporphyrins, and determined the means of the groups. These figures clearly indicate that the haem from a mixed diet significantly increases the non-coproporphyrins in faeces.

The patients used in this experiment were not taking a meat-free diet when the faeces were analysed, and this probably increased the porphyrin values in Europeans relatively more than in Bantus. It is noticeable, however, that abnormal urine-faeces porphyrin ratios in Bantus were still obtained in cases where stools showed strong or relatively strong occult blood results.

These findings are in agreement with those of Nesbitt *et al.*,[7-10] Watson *et al.*,[11-13] Dobriner,[14] Zeile and Brugsch[15] and Lageder,[6] who observed that urinary coproporphyrin is increased in cases of liver disease. The quantity of coproporphyrin found in our cases is also in agreement with the quantities found by these investigators.

Table V shows a definite correlation between the degree of porphyrinuria and the degree of abnormality of liver function, as is evidenced by the liver function tests and the urine-faeces porphyrin ratios. This is regarded as an important finding, relating abnormal porphyrinuria to impaired liver function in the Bantu. Furthermore, not a single case was found in which porphyrin excretion was increased without there being impaired liver function as well. Apparently the liver was unable to excrete the normal quantities of porphyrin in the bile.

Uroporphyrin Excretion in Liver Disease

According to Rimington *et al.*,[58,59] Schwartz[60] and Lockwood,[61] traces of uroporphyrin may be excreted in normal urine. As much as 5 - 20 μg. in 24 hours have been reported, while not less than 6 other non-coproporphyrins (NCP) were found in very small quantities. With and Petersen[62] found the excretion of NCP, including uroporphyrin, to be increased in a variety of diseases; as much as 50 - 500 μg. of NCP was found in serious, and mostly fatal, conditions.

In our cases described so far only coproporphyrin was found. With the method used, all the porphyrins could be extracted from acidified urine with ether. The excretion, if any, of NCP, must therefore have been very small.

During the investigation uroporphyrin was found in the

urine of only 5 Bantu patients. In 2 of them only morning urine could be obtained; in the remaining 3 it was possible to analyse complete 24-hour specimens and to carry out liver function tests. The results on these 3 patients were compared with the results found on 5 porphyria patients and are given in Table VII. The results on the 2 morning urines are given in Table VI.

The excretion of uroporphyrin in the porphyria patients varied from 605 to 2,800 μg. in 24 hours or 405 - 2,900 μg. per g. of creatinine. In the 3 non-porphyric patients it varied from 290 to 930 μg. in 24 hours or 240 - 930 μg. per g. of creatinine. A value within this range, i.e. 665 μg. per g. of creatinine, was also found in one of the patients where only morning urine could be obtained.

It is important to note that the excretion of uroporphyrin in the non-porphyric Bantu can be higher than the excretion of coproporphyrin. In the few patients examined, 1,000 μg. or more of uroporphyrin per 24 hours or per g. of creatinine were excreted in cases of porphyria and less than 1,000 μg. in the non-porphyric cases.

These 5 cases in which uroporphyrin was found showed no clinical signs of porphyria. In neither these nor the porphyria cases was porphobilinogen detected in the urine.

There was a marked difference as regards urobilinogen excretion in this non-porphyric group and the previous group in which only coproporphyrin excretion in urine was increased. Urobilinogenuria apparently parallels coproporphyrinuria and not uroporphyrinuria; normal excretion of urobilinogen may be accompanied by a marked increase in uroporphyrin excretion.

Abnormal liver function tests were obtained in the porphyric as well as the non-porphyric patients. It can therefore be assumed that impaired liver function probably contributes to the excessive porphyrin excretion in Bantu porphyrics.

According to these results those Bantus who excreted uroporphyrin may be grouped between those who showed excessive coproporphyrinuria and those who had porphyria. It is difficult to explain the metabolic relationships, but this group may be regarded as a transition stage between pathological porphyrinuria and porphyria. As in the case of copro-

TABLE IV. PORPHYRINS IN URINE AND FAECES AND LIVER FUNCTION TESTS IN EUROPEAN PATIENTS

	Urine						*Faeces*					
Patient	*Volume*	*Creatinine (g./24 hrs.)*	*Coproporphyrin (μg./24 hrs.)*	*Coproporphyrin (μg./μg. creatinine)*	*Urobilinogen (mg./24 hrs.)*	*Urobilinogen (mg./g. creatinine)*	*Coproporphyrin (μg./g. dry weight)*	*Protoporphyrin (μg./g. dry weight)*	*Total Porphyrin (μg./g. dry weight)*	*Urine-Faeces Porphyrin Ratio*	*O-Tolidine Reaction*	*Amidopyrin Reaction*
25	980	1·7	26	15	0·8	0·5	10	40	50	1 : 3	4+	2+
26	1900	1·6	28	17	0·6	0·4	15	20	35	1 : 2	4+	2+
27	1200	0·79	25	31	0·6	0·8	12	26	38	1 : 1	3+	+
28	2270	1·1	40	36	1·3	1·2	10	15	25	1·5 : 1	3+	+
29	2579	1·1	45	41	1·3	1·2	10	31	41	1 : 1	4+	2+
30	1850	1·2	53	44	0·5	0·4	6	31	37	1 : 1	4+	2+
31	1820	1·1	99	90	0·2	0·1	11	53	64	1·5 : 1	3+	+
32	1160	1·3	77	60	0·3	0·23	2	10	12	5 : 1	4+	2+
33	2160	0·8	76	95	3·1	3·9	9	9	18	5·5 : 1	4+	2+
34	1750	1·3	186	143	6·2	4·8	1	6	7	18 : 1	2+	—
35	720	0·6	112	187	0·4	0·6	14	49	63	3 : 1	4+	2+

TABLE IV (*Cont.*) LIVER FUNCTION TESTS

Patient	*Thymol Turbidity*	*Thymol Flocculation Units*	*Colloidal-red Test*	*Cephalin-Cholesterol Flocculation*	*Takata-Ara Reaction*	*Zinc-sulphate Turbidity units*	*Alkaline Phosphatase Activity units*	*Van den Bergh Reaction*	*Bilirubin (Direct) mg.%*	*Bilirubin (total) mg.%*	*Total Protein g.%*	*Albumin g.%*	*Globulin g.%*	*Gamma Globulin g.%*	*Cholinesterase Activity %*
25	2·5	—	—	—	—	10·6	5·1	—	0·2	0·5	7·6	3·7	3·9	1·02	100
26	3·5	—	—	2+	—	15·0	12·8	—	0·2	0·5	7·3	3·9	3·4	1·27	100
27	3·5	3+	3+	—	—	17·8	10·5	—	0·2	0·6	6·6	3·6	3·0	1·27	73
28	1·5	—	—	—	—	14·0	6·4	—	0·2	0·5	7·5	4·2	3·3	1·27	100
29	2·0	—	+	2+	—	13·3	5·7	—	0·2	0·6	7·4	4·1	3·3	1·27	100
30	2·0	—	—	—	—	9·8	4·6	—	0·2	0·5	7·0	3·9	3·1	0·96	100
31	1·0	—	—	2+	—	10·6	10·8	—	0·2	0·5	6·4	3·3	3·1	1·21	73
32	3·0	—	—	+	—	13·8	10·4	—	0·2	0·5	6·9	3·0	3·9	1·02	100
33	5·5	3+	4+	4+	++	32·2	16·9	—	0·2	0·5	6·3	2·5	3·8	2·57	37
34	5·5	4+	4+	—	—	19·6	25·6	*	0·5	1·5	7·0	3·6	3·4	1·34	68
35	2·5	—	3+	2+	—	9·0	9·5	*	0·4	1·1	6·6	4·1	2·5	0·78	78

* Delayed direct Van den Berg reaction.

porphyrinuria, the excretion of uroporphyrin can also vary from day to day (see Table VI).

Very little is known of the biochemical abnormalities in acute porphyria and in the cutanea tarda type; apparently these diseases are not caused by abnormalities of the erythropoietic system.[63-69] Acute porphyria is characterized by the presence of porphobilinogen, especially in the liver, the organ which is apparently responsible for the biochemical abnormality.[70-72] The conversion of porphobilinogen to porphyrin in the liver may be blocked, as is evidenced by a decrease in liver catalase activity in experimental porphyria which corresponds well to the acute hepatic type in the human.[73, 74] It is also possible that excessive production of porphobilinogen and porphyrin takes place in the liver.[71, 72]

Taking the above findings into consideration, the excessive excretion of uroporphyrin in non-porphyric Bantus may be explained in a similar way. Liver function is probably impaired to such an extent that catabolism of uroporphyrin

TABLE V. PORPHYRINS IN URINE AND FAECES AND LIVER FUNCTION TESTS IN BANTU PATIENTS

	Urine						*Faeces*					
Patients	*Volume*	*Creatinine (g./24 hrs.)*	*Coproporphyrin (µg./24 hrs.)*	*Coproporphyrin (µg./g. creatinine)*	*Urobilinogen (mg./24 hrs.)*	*Urobilinogen (mg./24 hrs.)*	*Coproporphyrin (µg./g. dry weight)*	*Protoporphyrin (µg./g. dry weight)*	*Total Porphyrin (µg./g. dry weight)*	*Urine-Faeces Porphyrin Ratio*	*O-Tolidine Reaction*	*Amidopyrin Reaction*
36	1080	1·3	7	5	0·63	0·49	3	3	6	1 : 1·2	3+	+
37	2100	0·9	12	13	0·11	0·12	2	3	5	2·5 : 1	±	±
38	1600	1·1	20	18	0·06	0·05	4	8	12	1·5 : 1	—	—
39	353	0·46	9	19	0·04	0·08	6	11	17	1 : 1	2+	—
40	2460	1·1	27	24	0·15	0·14	6	6	12	2 : 1	2+	—
41	1240	1·04	26	25	0·41	0·39	18	93	111	1 : 4·4	2+	—
42	870	0·6	37	62	0·2	0·3	7	35	42	1 : 5·1	3+	+
43	1220	1·02	65	64	1·35	1·32	5	12	17	4 : 1	3+	+
44	920	0·83	61	74	5·2	6·3	24	19	43	1·7 : 1	3+	2+
45	470	0·24	19	80	0·03	0·12	6	12	18	4·5 : 1	3+	+
46	1460	1·4	147	105	0·60	0·5	13	14	27	4 : 1	4+	3+
47	1610	0·73	103	142	5·30	7·3						
48	2100	0·885	138	156	3·56	4·02	4	22	26	6 : 1	—	—
49	1480	1·2	188	157	21·0	18·0	4	9	13	12 : 1	3+	+
50	930	0·93	156	168	0·15	0·16	11	13	24	7 : 1	+	—
51	2100	1·3	241	185	0·45	0·34	0·7	2	2·7	68 : 1	2+	+
52	1010	0·93	186	200	47·0	50·5	26	17	43	4·7 : 1	2+	—
53	1200	1·0	320	320	3·5	3·5	36	57	93	3·4 : 1	4+	3+

TABLE V (*Cont.*). LIVER FUNCTION TESTS

Patient	*Thymol Turbidity units*	*Thymol Flocculation*	*Colloidal-red Test*	*Cephalin-Cholesterol Flocculation*	*Takata-Ara Reaction*	*Zinc-sulphate Turbidity units*	*Alkaline Phosphatase Activity units*	*Van den Bergh Reaction*	*Bilirubin (direct) mg.%*	*Bilirubin (total) mg.%*	*Total Protein g.%*	*Albumin g.%*	*Globulin g.%*	*Gamma Globulin g.%*	*Cholinesterase Activity %*
36	1·5	—	—	—	—	12·4	9·5	—	0·4	0·8	7·6	3·8	3·6	1·68	100
37	3·0	—	—	—	+	17·8	26·3	—	0·2	0·4	7·4	3·6	3·8	1·68	100
38	3·0	—	+	—	—	14·0	9·5	—	0·2	0·4	7·1	3·5	3·6	1·27	53
39	3·5	+	2+	—	++	28·8	12·1	—	0·2	0·4	8·9	3·9	5·0	2·44	83
40	4·5	2+	4+	—	++	26·8	9·8	—	0·2	0·4	7·9	3·8	4·1	2·20	75
41	6·0	4+	4+	—	+++	71·6	5·4	—	0·2	0·4	7·6	1·5	6·1	4·50	52
42															
43	3·5	—	4+	—	+++	30·0	6·8	—	0·2	0·5	7·0	2·3	4·7	2·68	69
44	4·5	4+	4+	—	+++	39·4	8·0	—	0·2	0·4	7·5	2·3	5·2	3·12	34
45	2·0	—	—		++	20·6	13·5	—	0·2	0·4	5·8	2·4	3·4	1·82	27
46															
47	6·0	3+	4+	++	+++	34·6	12·1	—	0·2	0·4	6·6	2·8	3·8	2·06	51
48	8·0	3+	4+	++++	+++	47·4	8·8	—	0·2	0·4	7·3	2·2	5·1	4·60	11
49	4·0	4+	4+	++++	++	32·2	11·3	—	0·2	0·5	8·7	2·7	6·0	2·68	21
50	7·5	4+	4+	++++	+++	34·8	7·1	—	0·2	0·5	7·6	1·8	5·8	3·00	53
51	4·5	—	—	+++	+++	32·2	91·5	*	11·8	21·6	6·5	1·4	5·1	2·84	15
52	9·5	4+	4+	—			15·9		5·3	11·6	8·2				100
53	7·5	2+	4+	+++	+++	69·2	8·7	—	0·2	0·7	7·4	1·6	5·8	5·8	27

* Prompt direct.

TABLE VI. EXCRETION OF UROPORPHYRIN IN MORNING URINE OF TWO BANTU PATIENTS

Patient	Date	Volume (ml.)	Creatinine (μg.)	Coproporphyrin (μg.g volume)	Coproporphyrin (μg./g. creatinine)	Uroporphyrin (μg./vol.)	Uroporphyrin (μg./g. creatinine)	Total Porphyrin (μg./vol.)	Urobilinogen (mg./vol.)	Urobilinogen (mg./g. creatinine)	
54	18·3	160	89	14	155	3	38	17	193		
	21·3	250	105	13	123	—	—	13	123		
	25·3	250	120	16	129	7	59	23	188		
	28·3	170	80	11	133	3	35	14	168	1·00	12·00
	1·4	256	200	26	132	—	—	26	132	0·28	1·40
55	18·3	240	120	16	133	80	665	96	698		
	1·4	200	80	3	40	29	362	32	402	0·04	0·45

is blocked, with the result that it is excreted in the urine (abnormal enzyme systems may be the cause), or excessive production of porphyrin (and porphobilinogen) may take place in the damaged liver tissue. It is not known at present whether the biochemical defect in these patients is of such a nature that the condition is really one of latent porphyria which will later on develop into true porphyria.

SUMMARY

Since impaired liver function as well as increased excretion of urinary porphyrins are common findings in the Bantu, an attempt was made to correlate certain biochemical liver function tests with porphyrin metabolism. The results suggest a definite positive correlation.

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TABLE VII. EXCRETION OF UROPORPHYRIN AND LIVER FUNCTION TESTS IN 3 NON-PORPHYRIC (NOS. 61-63) AND 5 PORPHYRIC (NOS. 56-60) CASES

Patient	Volume	Creatinine (g./24 hrs.)	Coproporphyrin (μg./24 hrs.)	Coproporphyrin (μg./creatinine)	Uroporphyrin (μg./24 hours.)	Uroporphyrin (μg./g. creatinine)	Total Porphyrin (μg./24 hrs.)	Total Porphyrin (μg./g. creatinine)	Urobilinogen (mg./24 hrs.)	Urobilinogen (mg./g. creatinine)
56	1800	1·5	580	385	605	405	1185	790	1·37	1·0
57	2540	0·76	520	680	920	1200	1440	1880	1·28	1·68
58	1040	0·90	880	970	1350	1490	2230	2460	5·05	5·58
59	2240	0·85	500	600	2100	2500	2600	3100	0·34	0·45
60	960	0·96	1100	1150	2800	2900	3900	4050	4·8	5·0
61	2450	1·2	165	138	290	240	455	378	0·68	0·57
62	1790	1·1	430	390	880	800	1310	1190	0·47	0·43
63	2240	1·0	484	484	930	930	1414	1414	0·07	0·07

TABLE VII (*Cont.*). LIVER FUNCTION TESTS

Patient	Thymol Turbidity units	Thymol Flocculation	Colloidal-red	Cephalin-Cholesterol Flocculation	Takata-Ara Reaction	Zinc-sulphate Turbidity units	Alkaline Phosphatase units	Van den Berg Reaction	Bilirubin (direct) mg.%	Bilirubin (total) mg.%	Total Proteins g.%	Albumin g.%	Globulin g.%	Gamma Globulin g.%	Cholinesterase Activity %
56	8·5	3+	4+	2+	+++	42·0	6·1	—	0·3	0·6	8·2	2·9	5·3	3·79	77
57	5·0	2+	2+	—	+++	22·6	12·4	*	0·2	0·2	7·7	2·4	5·3	1·82	62
58	8·0	4+	3+	—		15·8	12·4	—	0·2	0·9	7·9	3·3	4·6	1·54	15
59	7·5	2+	3+	—	+++	25·6	7·8	—	0·2	0·4	6·5	2·8	3·7	2·06	53
61	4·0	+	2+	2+	+	19·6	7·5	—	0·2	0·4	7·1	3·6	3·5	1·61	68
62	3·0	—	4+	—	+	16·8	7·4	—	0·2	0·4	6·1	3·1	3·0	1·47	66
63	5·0	—	4+	—	++	32·2	14·6	—	0·3	0·6	8·0	2·1	5·9	2·59	100

* Delayed direct.

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