III. THE HYDROGEN ION CONCENTRATION OF THE FAECES OF RACHITIC CHILDREN.

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(Received November 14th, 1927.)

THE investigation was undertaken as a sequel to work done on rats by Zucker and Matzner [1924], and by Bacharach and Jephcott [1926], in which it was found that the p_H of faeces of rats fed on a rickets-producing diet was consistently alkaline, but that when vitamin D was administered a change occurred in the reaction of the faeces, which gradually became acid and remained so—this change synchronising with the cure of the rachitic condition of the rats and, therefore, suggesting an excellent criterion for determining the clinical condition of the animal with regard to rickets. The importance in regard to rickets in children was at once suggested by these results in rats.

If so simple a method of following the clinical course of the disease could be obtained in rachitic children it would be of much value, especially at clinics where X-ray apparatus was not available. Consequently, the faeces of a number of rachitic children were examined for p_H and the same method used as in previous work [Redman, Willimott and Wokes, 1927], viz. the electrometric method with the quinhydrone electrode.

In the first place, faeces were obtained from rachitic children receiving artificial sunlight treatment (tungsten-cored carbon arc lamps) as out-patients.

Twelve unselected cases which had been treated for different periods, and varying in age from one to three years, were examined.

The following figures were obtained:

Table I.

Case	1	2	3	4	5	6	7	8	9	10	11	12
p_H	4.74	5.90	4.64	5.42	5.25	5.94	4.21	5.08	6.74	5.61	5.72	5.70

As these were all on the acid side it raised hopes that the children were all being cured and that the hypothesis would be found correct.

These children were all out-patients on varying diets. Twelve hospital cases were next selected that had been admitted as very severe rickets and had been under treatment for a considerable period. They were all on the same standard antirachitic diet. X-ray evidence showed healing in five cases (Nos. 13, 15, 18, 22 and 23) and that the other severe cases were improving, but not healed, at the time of commencing observations.

In Table II are given the details of the different treatments, the time in days taken to establish a cure according to X-ray findings, the number of days after admission to hospital before the first p_H value of the faeces was determined, and, finally, a few p_H values with the number of days' interval between the readings.

Table II.

No.	Age in years	Treatment	Time taken to cure according to X-ray (days)	Days after admission before p_H taken	1st p_H	Interval (days)	2nd p_H	Interval (days)	3rd p_H	Interval (days)	4th p_H
13	1 $\frac{3}{4}$	CLOM. AST.	143	162	4.99	16	6.17	8	4.59	5	4.50
14	4	CLOM. AST.	196	125	6.11	20	6.80	1	8.41	8	5.30
15	1 $\frac{6}{7}$	CLOM. AST.	138	216	6.02	14	5.32	7	8.29	—	—
16	3	CLOM. AST. and syr. fe. phos.	257	103	6.57	15	6.23	7	5.04	7	6.84
17	3	CLOM. and oleum phos.	191	102	5.59	15	6.05	7	5.05	7	4.97
18	2	CLOM.	223	295	5.11	14	7.49	3	6.13	7	5.53
19	2 $\frac{1}{4}$	AST., kalzana	178	123	6.45	16	7.36	6	7.10	7	8.70
20	2	CLOM. AST., kalzana	169	124	5.76	29	4.97	—	—	—	—
21	2	CLOM. AST., thyroid	174	138	5.33	20	6.41	—	—	—	—
22	3 $\frac{3}{4}$	AST.	166	182	7.28	10	6.76	5	6.02	1	7.54
23	2	CLOM. AST., kalzana	102	188	7.10	8	7.31	6	6.00	7	7.30
24		CLOM. AST., kalzana, thyroid	216	156	6.91	8	7.31	7	4.68	7	6.13

CLOM. = Cod-liver oil and malt.

AST. = Artificial sunlight treatment.

In the first set of reactions, only two were alkaline (Nos. 22 and 23) and these samples were from cured cases. Subsequent sets of reactions showed alkaline values in all cases but three, one of which was cured and two were not cured.

Samples of faeces from seven untreated cases of severe rickets and from two normal children were next examined, with the results shown in Table III.

Table III.

Cases of rickets				Normal children	
No.	p_H	No.	p_H	No.	p_H
25	7.71	29	6.13	32	5.53
26	4.60	30	5.08	33	6.49
27	5.61	31	8.56		
28	4.59				

Only two samples were found to be alkaline, both from cases of rickets. The rest were acid.

So far, no particular construction could be placed upon the reactions of the faeces obtained from untreated cases of rickets or cases that had received treatment in hospital for over 100 days. It was therefore decided to take some really severe cases of rickets that had received no treatment at all and to follow the reaction of the faeces over a number of days, keeping the children

in the hospital and feeding them all on the same standard antirachitic diet, but putting them on different treatments. Fourteen rachitic children (Nos. 34-47), aged 2 to 3 years, were selected, and, together with one normal child as control, were all put on the same diet. Two younger children (Nos. 48 and 49), aged 15 months, suffering from severe rickets were also included but they did not have the mince, chicken, or cocoa supplied to the older children. The diet of the older children consisted of:

Milk.	Custard.	Bread.
Cream.	Beef tea or chicken broth.	Rusks.
Cocoa, made with milk.	Mince.	Butter.
Raw egg beaten in milk.	Minced chicken.	Oranges.
Blancmange.	Bacon gravy.	

The different treatments were as follows:

1. Cod-liver oil and malt together with:
 - (a) Artificial sunlight (tungsten-cored carbon arc).
 - (b) Sunlight on balcony.
 - (c) Mercury vapour lamp.
2. Ostelin.
3. "British Drug Houses" irradiated ergosterol.
4. Irradiated ergosterol No. 2.
5. Radio-malt.
6. Irradiated cholesterol freshly prepared every few days.

The children were first kept on the special diet for 5 or 6 days without special treatment.

On the first three days no samples of faeces were collected, to allow as much as possible of the food taken previous to admission to hospital to be swept out of the alimentary canal before beginning the series of observations.

The staff was asked to collect daily as much as possible of the faeces passed in 24 hours and a representative sample was then taken from each case. The p_H was determined daily, first of all for 2 or 3 days before treatment was begun, then during treatment for periods varying from 26 to 49 days, except in a few cases where an interval was left after starting treatment to see if the hypothetical "consistently acid" state would have been reached before taking p_H values. It was not always possible to get the daily samples. Undoubtedly some of the children suffered from constipation, but more often the organisation broke down.

The results are shown graphically in Figs. 1 to 7. There are, of course, the gaps to be taken into account where "constipation" occurred (or, where sometimes the samples were thrown away), but a certain amount of comparison is possible between cases undergoing the same treatment.

Fig. 6 shows the curve obtained in the case of the normal child. On each of the other figures is marked the treatment given and a note of X-ray findings.

From Figs. 1 to 6 no correlation can be inferred between the p_H of the faeces and the condition of the patients with regard to rickets as shown by skiagrams.

Fig. 1.

Case	Curve	Treatment
34	— x —	Cod-liver oil and AST.
35	— • —	„ and balcony
37	- - □ - -	„ and Hg vapour lamp
X-ray, all nearly healed, 40 days

Fig. 2.

Case	Curve	Treatment	X-ray
38	— x —	Ostelin	Healed 61 days
39	— □ —	„	„ 58 days

The majority of the readings are markedly on the alkaline side in Fig. 1, but vary enormously from acid to alkaline and back, regardless of the condition of the patients in Figs. 2, 3, 4 and 5. In Fig. 6 the variations in the case of the control child on the same diet are quite as marked as in the cases of rachitic children.

Fig. 7 shows the curves for the two babies on the same diet and treatment, and for one older child on the same treatment, but different diet. It was unfortunate that the older child contracted measles, and observations could not be continued longer, as the reactions of the faeces were more on the

Fig. 3.

Case	Curve	Treatment	X-ray
40	— x —	BDH. ergosterol	Nearly cured 63 days
41	— □ —	" "	" 32 days

Fig. 4.

Case	Curve	Treatment	X-ray
42	— x —	Ergosterol (2)	Healing 30 days
43	— □ —	" "	" "

alkaline side than those of the babies. The faeces of one baby varied much more in their reaction than those of the other. The latter was cured more quickly than the former, and its faeces were only once alkaline, but the condition of one on admission was as bad as that of the other.

Fig. 5.

Case	Curve	Treatment	X-ray
44	--- x ---	Radio-malt	Nearly healed 38 days
45	— □ —	„	Healing 19 days

Fig. 6. Normal control child

Fig. 7.

Case	Curve	Treatment	X-ray
46	--- x ---	Irradiated cholesterol	Improved 19 days
48	— • —	„	Healed 35 days
49	— □ —	„	Nearly healed 36 days

CONCLUSION.

It has not been found possible to obtain a definite correlation between different stages of the disease of rickets and the p_H values of the faeces of the patients, under the conditions described in the paper. The p_H determinations were all made by means of the quinhydrone electrode.

I am deeply indebted to Dr A. Dingwall Fordyce and to Col. Macdiarmid for free access to cases under their care, to Dr Aidin, R.M.O., and the Staff of Alder Hey Hospital for their help and courtesy whilst the experiments were being carried out, and to Prof. Heilbron and Dr Kamm who prepared irradiated cholesterol and ergosterol used for some of the treatments. For part of the apparatus for the electrometric determinations I am indebted to the Royal Society.

The work was done in the Bacteriological Department, Liverpool University, during the tenure of the Virol Research Scholarship in Clinical Pathology.

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