

after the intravenous injection of 5 mg. per kilo. A simplified method of determining the amount of dye in the plasma has been devised: a series of standards for comparison is prepared by adding varying amounts of the dye to plasma prior to the injection.

The test was performed upon ten normal individuals and ten control cases of extra hepatic disease. Seventeen cases of liver disease of various types were tested and results fully bore out experimental findings; striking degrees of retention of the dye in the blood were present where known damage to the liver existed. Results are quantitative, they have harmonized with the clinical evidence of the extent of liver damage and it is believed that they give an index of the functional capacity of the entire liver.

43 (2003)

The effect of sunlight upon the concentration of calcium and of inorganic phosphorus of the serum of rachitic children.

By BENJAMIN KRAMER and FRANK H. BOONE.

[From the Department of Pediatrics, Johns Hopkins University, Baltimore, Maryland.]

Recent studies have shown that the bone lesions of rickets may be healed by a variety of measures (administration of a proper diet, or of cod liver oil, radiation with mercury vapor quartz lamp, carbon arc lamp, cadmium open spark, etc.) Hess and Unger¹ claim to have obtained a similar result by exposing children suffering with rickets to direct sunlight.

Howland and Kramer² have demonstrated that with active rickets, unassociated with tetany, there occurs regularly a marked reduction of the concentration of inorganic phosphorus in the serum. In some instances there was also a moderate reduction of the calcium concentration. With active rickets the reduction is such that when the concentration of calcium expressed in mg. per 100 c.c. of serum is multiplied by that of inorganic phosphorus similarly expressed, the product does not

¹ Hess, A. F., and Unger, L. J., *Journal of A. M. A.*, 1921, lxxvii, 39.

² Howland, John and Kramer, Benjamin, *Transactions of the American Pediatric Society*, 1922, xxxiv, 204.

exceed the value 30. When healing takes place the concentration of each element approaches the normal so that the value of the product is 40 or above. Since the calcium concentration in normal serum rarely exceeds 11 mg. per 100 c.c. of serum and that of inorganic phosphorus does not go beyond the upper limit of 6 mg. in the same volume of serum the product practically never exceeds the value 66.

The present study was undertaken:

1. To test the curative action of direct sunlight upon rachitic changes in the bones of children.
2. To determine whether the pigmented skin of the negro interfered with the therapeutic action of the sun's rays.
3. To demonstrate whether direct sunlight is capable of producing as definite an increase in the concentration of calcium and inorganic phosphorus in the serum as occurs with the agents above named.

Although Hess and Unger¹ claim to have produced healing of the rachitic process in the bones in from four to six weeks, Hess and Gutman² failed to find any significant changes of the inorganic phosphorus of the whole blood when children were exposed to sunlight for the same period.

Seven colored children suffering from active rickets were studied. Radiograms of all the extremities were taken before treatment was begun and at intervals during the treatment. The serum was also analyzed for calcium and inorganic phosphorus. The children were fed on milk dilutions and orange juice, a diet which, from previous experience, we have found will not itself cure rickets. The children were exposed to direct sunlight beginning with periods of fifteen minutes duration, then one half hour and finally one hour daily. In spite of intense pigmentation of the skin of some of the children, definite evidence of healing could be demonstrated in each instance by means of the radiogram during the third week of treatment. This was well marked by the end of the third week.

Table I shows that in every instance before treatment was begun the product of the calcium by the phosphorus concentration of the serum did not exceed 30, indicating the existence of active rickets. A marked change in the concentration of inorganic phosphorus occurred regularly within fourteen days

¹ Hess, A. F., and Gutman, M. B., *Journ. of A. M. A.*, 1922, lxxviii, 29.

and the normal level was reached within three weeks so that, at this time, the product approximated or even exceeded the value 60. Whenever the calcium concentration of the serum was low at the beginning of treatment it rapidly rose to the normal level during treatment.

CONCLUSIONS

I. The systematic exposure of children to the direct rays of sun regularly brings about healing of the rachitic process in the bones.

II. The pigmented skin of the negro does not interfere with the therapeutic action of the sun's rays.

III. The changes in the concentration of calcium and inorganic phosphorus are identical with those which follow the administration of cod liver oil or radiation with the mercury vapor quartz lamp.

IV. The action of sunlight is as prompt, if not more so, than that of other curative agents.

CALCIUM AND INORGANIC PHOSPHORUS CONCENTRATION OF
SERUM OF RACHITIC CHILDREN BEFORE AND AFTER
EXPOSURE TO SUNLIGHT

Name	Color	Age	Date	Cal- cium mg. per 100 of serum	Phos- phor- us mg. per 100 of serum	Pro- duct	
M. N.	Brown	6 mo.	6-10-22	8.8	2.8	30	Marked rickets.
			8-2-22	11.1	5.0	55	Definite healing.
M. D.	Black	1 yr.	8-8-22	11.0	3.0	33	Moderate rick- ets.
			8-18-22	10.5	4.2	44	Healed rickets.
G. F.	Dark brown	9 mo.	8-24-22	11.2	5.9	66	Rickets.
			8-11-22	10.6	3.0	32	
			8-24-22	10.3	5.0	51	
			9-1-22	10.1	4.7	47	
R. F.	Black	10 mo.	9-7-22	9.2	5.9	54	Healed rickets.
			8-11-22	9.3	2.8	26	Active rickets.
			8-24-22	10.3	4.1	42	
			9-1-22	10.1	5.7	58	
A. J.	Dark brown	15 mo.	9-7-22	9.8	6.4	64	Definite healing.
			8-16-22	9.3	2.5	23	Rickets.
			8-24-22	9.4	3.2	30	
			9-1-22	9.3	4.1	38	
E. C.	Black	16 mo.	9-7-22	9.8	5.9	58	Healing.
			8-18-22	9.8	2.5	25	Marked rickets.
			9-1-22	10.1	3.8	38	
L. Y.	Black	10 mo.	9-7-22	9.2	6.5	60	Definite healing.
			8-21-22	7.9	3.1	25	Rickets.
			9-7-22	9.0	5.1	46	Healing.

Child treated in the ward for three weeks. Radiogram of the extremities at the end of this time same as on June 10. Child then exposed to sunlight for three weeks, diet unchanged. Definite healing after 14 days.