of high fat, as versus low fat diets. They found that the diet high in fat caused the retention of more nitrogen than the low fat diet, when the protein intake was the same in both instances. Thus the energy made available by the combustion of fat caused more protein to be synthesized than the energy from an equicaloric quantity of another source. Therefore the animals on a high fat diet, who were receiving growth hormone at the same time, were getting a double stimulus to their protein synthetic process. This would put a greater strain on their reserves of pantothenic acid than that experienced by the animals on the high carbohydrate diet, and thus produce a more severe deficiency.

Lipmann and his associates (1,2) have clearly demonstrated that pantothenic acid exists in the tissues in the form of a coenzyme that is vitally concerned in acetylation reactions. They have studied these reactions extensively in the case of the acetylation of sulfanilamide in the liver. They believe that in the process of acetylation there is an intermediate stage in which the carboxyl group is phosphorylated, and thus "activated", as a preliminary to condensation. Since this process of acetylation of sulfanilamide represents the synthesis of a peptide bond, and since coenzyme A is necessary for its normal occurrence, it is logical to assume that pantothenic acid, in the form of this coenzyme, is involved in the reactions leading to the synthesis of proteins. Under conditions where there is an exaggerated rate of protein synthesis, as after the administration of the growth hormone, the rate of synthesis is depressed if adequate amounts of pantothenic acid are not available.

Summary. It has been shown that the adult female rat, whose growth curve has "plateaued", can be made to develop an acute pantothenic acid deficiency when stimulated to grow rapidly by the continued injection of anterior pituitary growth hormone. The deficiency, so produced, develops more rapidly and is more severe if the deficient diet is high in fat. It is concluded that pantothenic acid is required for the synthesis of protein in the body.

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Use of Radioactive Phosphorus to Determine Volume of Blood Replaced in Replacement Transfusion. (17585)

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Replacement transfusion has been advocated recently in the treatment of acute leukemia and acute renal failure. (1-3) The volume of blood replaced by such a procedure may be calculated mathematically if the mixing of blood in the body behaves as it would in a simple mechanical system. The agreement of a determination (using differential Rh typing) of the volume of blood replaced in a case of erythroblastosis fetalis (4) with a mathematically derived value supports this concept. Since the technic of labeling erythrocytes with radioactive phosphorus (5) provides a simple and widely applicable method for the determination of blood volumes, it was decided to evaluate the usefulness of this technic in the

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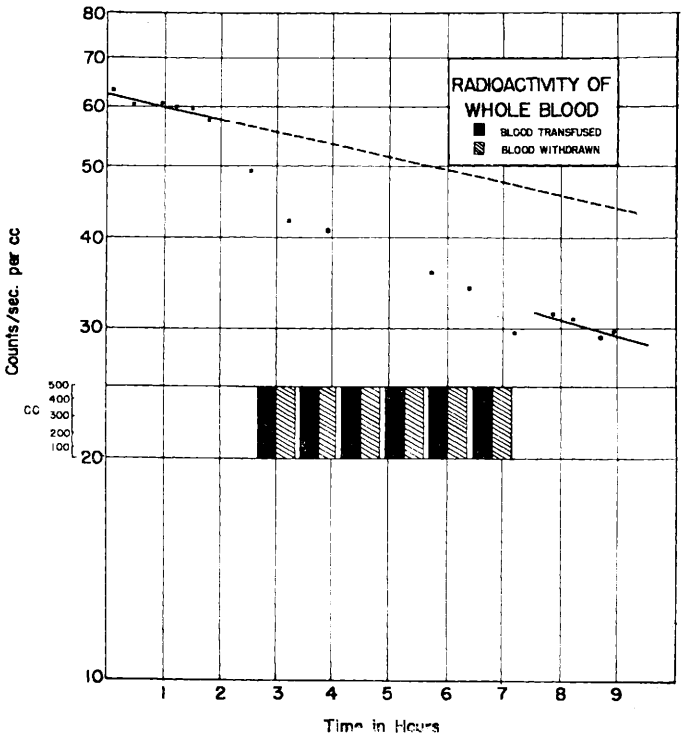

FIG. 1.

Graphic expression of data obtained from subject 2 (Table 1). The solid lines are drawn through the pretransfusion points and the post transfusion points. The interrupted line is extended from the solid line drawn through the pretransfusion points for the determination of predicted activity.

measurement of the volume of blood replaced in replacement transfusions, comparing the experimental results with values calculated mathematically.

Methods. Four replacement transfusions were carried out in 3 patients with acute leukemia and in one patient with chronic leukemia. Ten to 15 ml of whole blood were withdrawn in a heparinized syringe from the patient. The blood was incubated under sterile conditions with 100 microcuries of P^{32} at 37°C for a period of 2 hours with gentle stirring every 15 minutes. Following incubation, the blood was centrifuged; the sedimented cells were washed twice with normal physiological saline and resuspended to the original volume with saline. An aliquot of the resuspended cells was reinjected intravenously into the patient and another aliquot saved for radioactive assay. At 15, 30, 60, 90 and 120 minute intervals after the injection, samples of heparinized blood were withdrawn for radioactivity assay. After this 2 hour equilibration period, the replacement transfusion was carried out either by simultaneous continuous transfusion and withdrawal of blood, or by intermittent transfusions and withdrawals (500 ml at a time). The amount of blood transfused was varied from 1,075 ml to 12,500 ml. At the completion of the replacement transfusion, blood was again withdrawn after 15, 30, 60, and 120 minutes for radioactivity assay. For determination of radioactivity 0.050 or 0.075 ml of whole blood was plated on copper planchets and counted with a mica window Geiger Muller tube. Counts were 4 to 20 times background.

Determination of volume of blood replaced

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TABLE I.
Comparison of Determined and Theoretical Amounts of Blood Replaced.

Subject	Amt of blood transfused and withdrawn (ml)	Predicted activity (cps/ml)	Determined activity (cps/ml)	Determined percentage of original blood replaced (%)	Theoretical percentage of original blood replaced (%)	Difference (%)
1	1075	114	93.2	18.3	19.3	—1.0
2	3000	46.5	29.5	36.5	37.4	—0.9
3	3000	41.0	26.0	36.5	40.4	—3.9
4	12500	150	11.5	92.4	96.3	—3.9

using experimental data. The radioactivity of the blood was expressed as counts per second per ml and was plotted logarithmically as a function of time. Straight line curves were drawn through the pretransfusion points and the post transfusion points. The radioactivity, expressed as counts per second (cps) per ml, at any given time after the replacement transfusion was designated as *determined activity*. The radioactivity of the blood at the same given time, had no transfusion been given, was then estimated and designated as *predicted activity*. The predicted activity reflects the loss of P^{32} from the erythrocytes by exchange with plasma phosphorus. It was determined by extrapolating the pretransfusion curve to the time chosen for the determined activity. (Fig. 1). The percentage of the original blood replaced was calculated by the following formula:

$$\text{Percentage of blood replaced} = 100 - \frac{\text{determined activity (cps/ml)}}{\text{predicted activity (cps/ml)}} \times 100.$$

This calculation is based on the assumption that the rate of phosphorus exchange remains constant throughout the experimental period. This assumption is borne out by the similarity of slopes of the curves before and after transfusions.

Determination of the volume of blood replaced using mathematical formulae. If the whole blood volume is known, the percentage replacement may be calculated according to the following formulae:

a. $\frac{N}{n} \log_e n = C$

b. Percentage of blood replaced $=$

$$\left[1 - \frac{1}{n} \cdot e^{\left(\frac{-n(t-c)}{N}\right)}\right] \cdot 100$$

Where: n = volume of blood transfused; t = number of transfusions; N = whole blood volume calculated according to the method of Nieset, *et al.*(5)

Results. The percentages of blood replaced found by using the experimental data (determined %) and the mathematical formulae (theoretical %) are given in Table I. A comparison of the values arrived at by the two methods reveals a difference in percent ranging from 0.9 to 3.9.

Summary. Using erythrocytes tagged with radioactive phosphorus, the percentage replacement of blood in replacement transfusion can be determined. The values obtained agree well with mathematically derived values.

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