

Minnesota Section.

University of Minnesota, April 18, 1934.

7369 P

Effects of Various Salts on Carbohydrate Metabolism and Blood Pressure in Diabetic Children.

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The excessive loss of minerals from the body in diabetic acidosis has recently been presented quantitatively in detailed balance studies by Peters¹ and Atchley² and their co-workers. Kydd³ has emphasized the depletion of chloride in excess of other electrolytes, as if the base lost with the ketone acids might be derived from NaCl rather than from bicarbonate. He stresses the need for replacement of chloride during recovery from coma. Diabetic children not infrequently manifest an unusual craving for salt, even when not excreting ketone bodies in abnormal amounts. This has been interpreted by Joslin as most likely being due to the high potassium content of their vegetable diets.

The present study was suggested by our experience in the case of a 15-year-old boy, who, as he emerged from diabetic coma, begged for salt and voraciously consumed 80 gm. of NaCl in the course of 24 hours. The water intake was proportionately increased. When it was observed that the craving for salt did not abate long after the disappearance of ketosis and that the patient continued to take 60 gm. daily before being satisfied, he was placed in the metabolism ward where complete balance studies could be carried out under standard conditions. He was given a constant diet containing protein 16, fat 33, carbohydrate 42, and water 1200 gm. every 6 hours.

¹ Peters, J. P., Kydd, D. M., Eisenman, A. J., and Hald, P. M., *J. Clin. Invest.*, 1933, **12**, 377.

² Atchley, D. W., Loeb, R. F., Richards, D. W., Jr., Benedict, E. M., Driscoll, M. E., *J. Clin. Invest.*, 1933, **12**, 297.

³ Kydd, D. M., *J. Clin. Invest.*, 1933, **12**, 1169.

This was made up from powdered milk, bread, butter, eggs, cane sugar, lemon juice and a small amount of powdered yeast. The insulin dosage was kept constant for each period, totaling 32 units per day. This dosage of insulin permitted the occurrence of glycosuria in every 6-hour period, thus making comparative measurements possible.

Shortly after the study was undertaken, it was discovered (1) that the high NaCl intake was accompanied by an elevation of arterial blood pressure from an average of 110 mm. of mercury systolic and 80 diastolic to 175 systolic and 115 diastolic and (2) that the urinary excretion of glucose fell from a control level of between 60 and 70 gm. to between 10 and 20 gm. daily under the same conditions. Reduction of the NaCl intake to the control value of about 4 gm. daily caused a return of the glucose excretion to the original level and a fall in the blood pressure to normal. Ketosis was never present. Within a period of 3 months these effects have been reproduced 4 times in this patient. The changes in sugar output and blood pressure regularly took place in from 24 to 48 hours. Similar results as regards both glucose excretion and blood pressure changes have since been obtained under almost identical conditions in 2 other cases of moderately severe diabetes in which the salt-craving factor was much less prominent.

The effect of the high NaCl intake on the glucose tolerance curve was to lower the fasting and peak values without greatly shortening the period required for return to the fasting level.

In an attempt to determine whether either the Cl ion or the Na ion alone, rather than their combination, was responsible for the changes observed, the effects of sodium bicarbonate, sodium citrate and KCl were compared with those of similar amounts of NaCl. While the 2 other sodium salts had similar though less marked effects than NaCl, the potassium salt had an opposite action in the one case in which it was given at the rate of 5 gm. every 6 hours. In this instance the sugar excretion per 24 hours rose to nearly double that of the control period, while the systolic blood pressure fell to a level approximately 20 mm. of mercury below that of the control period. Both of these effects disappeared within 24 hours after withdrawal of the KCl.

These observations gain in interest when considered in the light of recent discoveries concerning the relationship of the hypophysis, the diencephalon, and the adrenal glands to sodium chloride balance, carbohydrate metabolism and blood pressure control. A single experiment on the effect of adrenal cortical hormone in large doses

(8 cc. of eschatin per day for 3 days), however, gave only negative results.

In the case of one normal control subject the ingestion of 15 gm. of NaCl every 6 hours caused an increase in blood pressure from 115/80 to 148/100 mm. of mercury, when the subject was on the simple, relatively-low-potassium diet given to the 3 diabetic children, but little or no change when he was taking an ordinary mixed diet containing liberal amounts of vegetables and meats. The possible effect on the carbohydrate metabolism of this subject was not determined.

Further studies are being made on (1) the specific effects of the different ions, (2) changes in blood volume with variations in salt intake and (3) effects, if any, of salt ingestion on the respiratory quotient.

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Effects of Radiation on Tissue Cultures of Lymph Node.

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Cultures of the mesenteric lymph node of adult rabbits were exposed to the type of radiation usually used for treatment of lymph nodes. The high voltage therapy machine at the University Hospital was utilized.

The water cooled X-ray tube was run with a current of 30 milliamperes at 200 K.V. A focus-surface distance of 50 cm. was used. The filter used in the preliminary experiments consisted of $\frac{1}{4}$ mm. copper plus 4.6 mm. aluminum (the aluminum in the ionization chamber).

The preliminary experiments consisted of cultures radiated with 1, 2, 4 and 8 erythema doses (800, 1600, 3200 and 6400 roentgens).

It became evident that higher doses were required to get the effects desired on the most resistant cells present.

The distance could not conveniently be reduced since it was desired to keep the cultures in a thermostat. In order to cut down the time of exposure the copper was removed from the filter, leaving the 4.6 mm. aluminum. The radiation was continued for 145 min. The absorption in the glass vessels was about 5%. With this taken