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STUDY OF SOME CASES OF DIABETES INSIPIDUS WITH SPECIAL REFERENCE TO THE DETEC- TION OF CHANGES IN THE BLOOD WHEN WATER IS TAKEN OR WITHHELD *

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Several years ago¹ we published a study of a case of diabetes insipidus in which, among other points, attention was directed to the question, whether any well marked changes could be detected in the blood when the water intake was greatly restricted or water taken at discretion. The patient had an enormous diuresis and a correspondingly great thirst, so that the conditions seemed unusually favorable for the inquiry. The conductivity of the serum and the relative volume of the serum and corpuscles were selected for study because the conductivity can be measured with great accuracy, and from the conductivities of the serum and blood the percentage volume of serum can also be obtained to a close approximation. Even when great changes were taking place in the rate of absorption, elimination and transportation of water, it was found that the two quantities measured altered only very slightly, although there seemed to be a small increase in the conductivity and a small decrease in the relative volume of the serum when water was severely restricted. But the extreme variation for the conductivity of the serum was only 5 per cent. in observations made at an interval of five days (from 78.6 to 82.5 were the extreme values of $K \times 10^4$ at 5 C.). The percentage volume of serum varied from 83 to 79, again about 5 per cent. The woman had a severe anemia. In the absence of a greater number of observations than it proved possible to obtain on this patient, we cannot be quite sure that even the small differences observed were directly related to the changed intake or output of water.

We have since observed two additional cases. In neither case, however, was the diuresis as great as in the first case. Only in one of the cases (Case 1) were we able to obtain what we considered a fairly sufficient number of observations. They are summarized in Table I.

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1. Christie, C. D., and Stewart, G. N.: Arch. Int. Med. **20**:10 (July) 1917.

TABLE 1.—CONDUCTIVITY AND RELATIVE VOLUME OF BLOOD SERUM IN C. S.

Date	K x 10 ⁴ at 5 C.			Percentage Volume of Serum		Remarks
	Serum	Blood	Electrical Method	Hematocrit		
Feb. 6, 9:30 a. m.	74.6	21.8	44.4	26.5 (10 m.), 40.5 (40 m.), 43 (60 m.).....	After 25½ hours without food or water. Duplicate blood samples	
10:00 a. m.	74.6	21.7	44.3	38 (30 m.), 39 (40 m.), 40 (55 m.), 41 (65 m.).....	Food and 2,000 c.c. water taken from 9:30 to 10 a. m. Water taken thereafter as desired	
3:30 p. m.	75.4	21.0	42.6	37 (15 m.), 47 (45 m.), 48 (61 m.).....	Duplicate blood samples	
Feb. 7, 9:30 a. m.	76.4	25.9	50.2	50.2		
	76.4	25.9	50.2			
Feb. 8, 10:45 a. m.	75.9	28.8	55.1	45.5 (15 m.), 51.5 (45 m.), 52.5 (55 m.).....	Abstention from water and food begun at 9:30 a. m. Means of duplicate blood samples	
11:15 a. m.	76.8	29.4	55.3	41 (10 m.), 51.5 (40 m.), 53.5 (60 m.).....	After 25½ hours without food or water. Means of duplicate blood samples	
5:00 p. m.	75.7	28.1	54.1	41.5 (10 m.), 53 (40 m.), 54 (60 m.).....	Food and 2,440 c.c. water taken from 10:45 to 11:15 a. m. Duplicate blood samples	
	75.7	28.1	54.1		Means of duplicate blood samples. Water at discretion since 10:45 a. m.	
	77.0	33.5	61.1	50 (10 m.), 57 (25 m.), 60 (50 m.).....		
Feb. 9, 9:30 a. m.	76.8	31.6	58.6	50 (10 m.), 55 (25 m.), 58 (50 m.).....	Abstention from water and food begun at 9:30 a. m.	
Feb. 10, 11:00 a. m.	75.4	30.2	57.6	41 (10 m.), 52 (35 m.), 54 (50 m.).....	After 25½ hours abstinence	
11:30 a. m.	75.6	28.2	54.4	41 (10 m.), 50 (35 m.), 52 (50 m.).....	After taking food and 2,500 c.c. water from 11 to 11:30 a. m. Thereafter at discretion	
5:45 p. m.	77.5	35.2	63.0	38 (10 m.), 54 (35 m.), 55.5 (50 m.).....		
Mar. 10, 11:00 a. m.	73.5	31.3	60.7	56 (10 m.), 58 (25 m.), 58.5 (35 m.).....	Abstention from water and food begun	
Mar. 11, 11:00 a. m.	80.7	32.1*	59.6	52.5 (10 m.), 57 (25 m.), 58 (40 m.).....	After 24 hours abstinence	
	81.0*	35.2*	60.3			
Apr. 20, 11:00 a. m.	75.4	30.0	57.3		Abstention from water and food begun	
Apr. 21, 11:00 a. m.	72.8	29.3	58.2	49 (11 m.), 55 (31 m.).....	After 24 hours abstinence	
	72.0*	28.5*	57.6*			
Apr. 23	78.0	32.3	58.7	45.5 (10 m.), 52 (20 m.), 53.5 (31 m.).....	After 24 hours abstinence from food and water	
	78.5*	33.1*	59.4*			

* Specimens obtained after injection of 12 c.c. congo red solution.

The observations were made at different times during eleven weeks, and the relative constancy of the serum conductivities, in spite of the changes imposed in the intake of water and the accidental changes which might be expected to occur over so long a period, is quite striking. The greatest variation was from 72.8 to 80.7, and the average of all the observations 76. The values obtained after injection of congo red solution for estimation of the blood volume are left out in calculating the average, although there would be practically no change if they were included, since the quantity injected causes no sensible alteration in the conductivity. The variation in the percentage of serum was greater than that in the serum conductivity, from 42.6 to 63 per cent., the average percentage for all the observations being 55.7. It so happens that all the serum percentages in the first series of observations (February 6) are lower than in any of the other series. It is not known that this was due to any experimental error. The only error which could possibly have caused such a result, so far as we can see, would be the loss of some of the serum in the manipulations before the blood was brought to the laboratory. But it is very difficult to understand how this could have affected all the specimens. Also duplicate specimens were taken in two observations, and the duplicate determinations are identical. It seems, therefore, more likely that the observations are correct, and that, for some reason unknown to us, there was a considerable increase in the relative volume of serum between February 6 and February 7. The hemoglobin content was seen to diminish somewhat throughout the series of experiments, accompanied by a slight diminution in the erythrocyte count. The average quantity of blood taken for each determination was not less than 20 c.c., so that it is possible that the mere loss of blood might, in part at least, account for this. The conductivities of the serum specimens of February 6 are not out of line with those of the rest of the series. If the serum percentages of February 6 are omitted the variation for the rest of the observations is from 54.1 to 63 per cent. and the average 58. There was only slight anemia in this patient, the erythrocyte count being in the neighborhood of 5,000,000, at the beginning, declining to 4,500,000 toward the end of the period.

As in the previously reported case, the percentage of serum was determined by the hematocrit as well as by the electrical method. It will be seen, as before, that the longer the centrifuge is turned the closer does the hematocrit reading approximate to the result of the electrical determination. The number of minutes rotation of the hematocrit (at about 4,000 turns a minute) is given in parentheses after the corresponding serum percentages.

The general plan of the observations was as follows: The patient being on his usual diet and taking water at discretion, a blood sample

(or generally two samples for duplicate determinations) was obtained, and the blood defibrinated. The electrical conductivity of the blood and serum and the percentage volume of serum were determined. The patient was then deprived of food and water, in the case of C. S. (Case 1) for twenty-four hours or longer, as he bore the deprivation well. Blood samples were obtained at the end of the period. Then he was allowed food and as much water as he could drink, and blood drawn at the end of thirty minutes, and again at the end of five or six hours, water and food being taken. Several sets of observations of this type were made on C. S. In none was there any material difference in the percentage of serum in the samples taken before and at the end of the period of abstention from water. The conductivity of the serum was also practically unchanged, except in the observations of March 10 to 11, when there was an apparent increase of about 10 per cent. at the end of twenty-four hours abstention from water.

The samples taken half an hour after renewed water ingestion showed practically no change in the serum conductivity, while in several of the sets of observations it seemed that a slight diminution in the percentage of serum occurred. More striking was the increase in the percentage of serum in the samples drawn from five to six hours after the taking of water had been resumed. This is seen in the observations of February 6, February 7 to 8, and February 9 to 10. The increase in the relative volume of the serum was not apparently accompanied by any diminution in the concentration of the salts, since the serum conductivity remained unaltered, or if anything, underwent a slight increase.

In Case 2 (U.A.), like Case 1, one of medium severity, the range of variation in the conductivity of the serum in all the observations was from 77.3 to 86.8. Although the mean of all the observations (82.2) was somewhat higher than in Case 1, the maximum range was about the same. However, the number of observations obtained in Case 2 was smaller than in Case 1, and they were spread over a much shorter period. In the most complete series in Case 2 (May 5 and 6) (Table 2) there was an increase in the conductivity of the serum after abstention from water for twelve hours (from 79.2 to 86.8. This was accompanied by a more marked diminution in the percentage volume of the serum (from 70.9 to 58.3 per cent.). On taking water, the proportion of serum increased. However, in the first experiment (April 20 to 22) when abstention was carried to the possible limit in this case (twenty-seven hours) a slight diminution of the conductivity was seen (from 82.0 to 77.3) accompanied by a marked increase in the proportion of the serum, while on April 30 the ingestion of 2 liters of water in twenty minutes after twelve hours abstention was associated with a slight increase in the conductivity of

TABLE 2.—CONDUCTIVITY AND RELATIVE VOLUME OF BLOOD SERUM IN U. A.

Date	K × 10 ⁴ at 5 C.		Percentage Volume of Serum		Remarks
	Serum	Blood	Electrical Method	Hematocrit	
Apr. 20	82.0	34.7	58.0	34 (14 m.), 45 (22 m.), 48 (29 m.), 50.5 (37 m.) 53 (49 m.)	Before abstinence from water
Apr. 22	77.3	44.1	74.0	63 (14 m.), 65.5 (20 m.), 68 (30 m.), 68.5 (35 m.)...	After 27 hours abstinence
Apr. 28	79.0	33.4	59.5	52 (15 m.), 56 (23 m.), 58 (33 m.).....	Water taken at discretion since April 22
Apr. 30, 10:00 a. m.	82.8	36.1	60.0	45 (10 m.), 52.5 (30 m.), 54.5 (30 m.).....	After 12 hours abstinence from water
Apr. 30, 10:20 a. m.	85.6	36.1	50.6	20 (10 m.), 39 (20 m.), 43.5 (30 m.), 46 (40 m.).....	After 2,000 c.c. water had been taken in 20 minutes
May 5	79.2	42.8	70.9	60 (10 m.), 64.5 (30 m.), 66 (27 m.).....	Before abstinence from water
May 6, 10:30 a. m.	80.8	35.9	58.3	53 (10 m.), 55.5 (30 m.), 56 (25 m.).....	After 12 hours abstinence from water
May 6, 11:00 a. m.	81.8	42.9	66.3	58 (10 m.), 60 (20 m.), 61.5 (25 m.), 63 (30 m.), 64.5 (37 m.)	After 1,575 c.c. water had been taken in 30 minutes

TABLE 3.—CONDUCTIVITY AND RELATIVE VOLUME OF BLOOD SERUM IN C. V.

Date	K × 10 ⁴ at 5 C.		Percentage Volume of Serum		Remarks
	Serum	Blood	Electrical Method	Hematocrit	
Nov. 29	90.2	29.5	53.1	43.5 (12 m.), 47 (18 m.), 49 (25 m.).....	Before abstinence from water and food
Nov. 30	...	...	...	42 (22 m.), 44 (32 m.), 45 (38 m.).....	At end of 24 hours abstinence from water
Nov. 30	87.1	30.9	49.4		After food and water had been taken at discretion for 1 hour

the serum, and a distinct diminution in the proportion of serum. We prefer not to attempt a hypothetic explanation of these variable results, simply pointing out that in Case 2 the relative volume of the serum was more variable than in Case 1, the extreme range being from 50.6 to 74 per cent. and the average of all the observations 62 per cent. It should be noted that in Case 2 deprivation of water was not nearly as well borne as in Case 1, the patient complaining much more of thirst. Also U.A. (Case 2) was allowed food during the period of deprivation of water, although he ate less than usual.

The observations in these cases illustrate, perhaps, even more clearly than those previously published, how trifling the changes in the concentration of the blood plasma, as regards the electrolytes, may be when great changes in the ingestion, excretion and transportation of water are in progress. So far as our experience goes it would seem that it is only in exceptionally favorable circumstances that even minute changes in the conductivity of the serum, a quantity capable of being measured to so considerable a degree of accuracy, can be detected with certainty. Observations which profess to demonstrate considerable and constant variations, associated with the taking or withholding of water should, we think, be received with reserve.

The relative volume of the blood plasma may undergo somewhat greater variations. This agrees with the conclusion of Farkas,² in an extensive research on the influence of water and salt given with the food on the water content of the organs in some of the domestic animals. In sheep caused to drink large quantities of water with or without sodium chlorid, the osmotic pressure and the concentration of the electrolytes remained the same; but the water content of the blood was increased in the sheep which received salt as well as water. According to Adolph,³ the drinking of isotonic salt solution by normal persons is accompanied by a measurable diminution in the hemoglobin content of the blood, indicating some increase in the water content. The possibility should not be lost sight of that in cases of diabetes insipidus the variations may be even less than in normal individuals, the urine secreting mechanism being, perhaps, even more responsive to slight changes in the blood, or the tissues less capable of storing any excess of water.

We do not intend to discuss the mechanism by which the osmotic pressure and the concentration of electrolytes in the plasma (as measured by the electrical conductivity) are maintained relatively constant during the absorption or excretion of large quantities of water. The exchange between the erythrocytes and the plasma, as well as the exchange between the tissue liquids and the plasma through the

2. Farkas, K.: *Mitth. aus. d. Königl. Ungar. Tierphysiol. Versuchsstation in Budapest*. No. 3, Berlin, 1908; *Landwirtschaftliche Jahrb.*, 1908.

3. Adolph, E. F.: *J. Physiol.* **55**:114, 1921.

capillary walls, must play a part. As to the relative volume of plasma and corpuscles, although the changes were probably greater than those in the conductivity of the serum, they were too small in amount, and not constant enough in sign, to permit the assumption that when water was withheld, any important part of the water which continued to be excreted could have been credited to a diminished water content of the blood, or that when water was again taken, any important part of it went to recoup the blood for its previous loss. The chief changes must have been in the tissue water. The slight apparent diminution in the percentage of serum in the first half hour after resumption of water intake, if it is a genuine diminution, might possibly have been associated with a preliminary speeding up of the diuresis. The increase in the proportion of serum a few hours later, perhaps to something more than the amount present at the beginning of the period of abstention, is most naturally associated with a rapid absorption slightly outstripping the diuresis. However, this is not the only possible explanation, and as has been previously said, speculations founded on such data as we have been able to obtain would, in the present state of our knowledge, be of little value. This is well illustrated by the marked increase in the proportion of serum, accompanied by a slight decrease in the conductivity, seen in the observations of April 20 to 22 in Case 2, after twenty-seven hours abstention from water. Whether the fact that some solid food was taken in this case influenced the result, it is impossible to say.

REPORT OF CASES

CASE 1.—C. S., male, married, aged 39, was admitted to the Lakeside Hospital medical service, Feb. 3, 1921.

Past History.—Essentially negative, aside from an attack of pneumonia five years ago. No history of any venereal infection.

Present Illness.—The patient dates his present trouble from July, 1920, when he noticed that he was becoming more irritable and much more easily fatigued. He had been an active man, but he now became so tired that his one desire was to lie down and sleep. He arose late each morning and retired early, and usually spent most of his Sundays in bed. Four months ago he began to have headaches, which he described as "heavy aches," coming every two or three days and lasting from a few minutes to half a day. They seemed to distress him more at night, and would sometimes awaken him. About one month after the headaches started, he noticed that he was gradually drinking more water each day and was passing an excessive quantity of urine. He said that his thirst reached such a degree that he would drink from three to four glasses of water every half hour and pass a corresponding amount of urine.

Physical Examination.—The patient is a well developed and well nourished man, and gives the appearance of being in good health. He is extremely neurotic, apprehensive, prone to complain and very restless. There is considerable dryness of the skin and a slight anemia. The eyes and eye grounds are normal. There is no evidence of cardiac enlargement. Blood pressure is not elevated. There is no acceleration of the pulse rate; no abnormal physical signs about the abdomen or the extremities. A complete neurologic examination revealed no abnormal findings.

Urine.—The urine was pale and of low specific gravity; no albumin or sugar. The quantity varied from 6 to 10 liters in the twenty-four hours.

Blood.—The blood showed: hemoglobin from 80 to 90 per cent. (Tallquist); white blood count, from 5,000 to 7,000; red blood count varied from 4,500,000 to 5,000,000. Blood sugar estimations showed from 0.085 to 0.090 gm. per hundred c.c. (by Lewis and Benedict method); blood urea varied between 0.025 and 0.032 gm. per hundred c.c.

Spinal Fluid.—Lumbar puncture revealed no increase in pressure; fluid normal in color; no cells. The Wassermann, globulin and gold chlorid tests were negative.

Head.—Roentgenograms of the region about the sella turcica showed no evidence of a pathologic process.

Kidneys.—Renal test meals, given when the patient was getting three daily intramuscular injections of 1 c.c. of a pituitary extract (pituirrin) showed an output of from 2 to 3 liters and that the patient's kidneys were quite able to concentrate the urine.

Dec. 15, 1921, the patient, who had become insane, shot himself in the left chest and died December 25. Diagnosis: "encysted hematoma, empyema and collapse of the left lung." The necropsy gave no information as to the possible cause of the polyuria. The pathologic examination of the brain, including the pituitary, showed nothing abnormal.

CASE 2.—U. A., male, single, aged 16; admitted to Lakeside Hospital medical service, April 7, 1920.

Past History.—He had had when a child the ordinary diseases.

Present Illness.—He dates his present trouble from the time he was 5 years old, when he had a cold and was feverish one night, and began drinking water excessively and urinating frequently. He was apparently worse at that time, from the statement of his parents, as he was not allowed to enter school until he was 7 years of age because of the trouble. Since the complaint began, eleven years ago, there has been no marked abatement of symptoms.

Physical Examination.—The patient is well developed and well nourished, and does not have the appearance of being ill. There are a few small brown pigmented areas over the face. The eyes are normal; the pupils react to light and accommodation; eye grounds are normal; no disturbance in the field of vision. The heart is not increased in size, and the pulse is regular and of good volume. The systolic blood pressure varied between 130 and 120 and the diastolic between 79 and 60. Examination of the abdomen and extremities was negative. A complete neurologic examination revealed nothing pathologic.

Urine.—The urine varied between 5 and 10 liters per twenty-four hours. It was pale, and the specific gravity varied between 1.002 and 1.005, except when the fluid intake was restricted or when the patient was given pituitary extract (1 c.c. three times daily, intramuscularly), and then the output was cut down and the specific gravity elevated. No albumin, casts or sugar.

Blood.—The blood showed: hemoglobin, 90 per cent. (Tallquist); white cells, 10,000; red cells, 5,200,000. Blood sugar, 0.10 gm. per hundred c.c., and blood urea, 0.030 gm. per hundred c.c.

Head.—Roentgenograms of the region about the sella turcica revealed nothing abnormal.

Kidneys.—The phenolsulphonaphthalein excretion was 78 per cent. in two hours.

Discussion of the Clinical Aspects of Cases 1 and 2.—There was nothing unusual about these cases other than that the patients had a diabetes insipidus of medium severity. Nothing was made out, either on physical examination or from the laboratory procedures, which gave us any clue to a possible etiology.

Both Cases 1 and 2 responded to the intramuscular injection of pituitary extract when given in 1 c.c. doses. The thirst and diuresis promptly subsided, and if three daily injections of 1 c.c. were given, the urine output could be cut down from 5 to 12 liters to below $2\frac{1}{2}$ liters in the twenty-four hours. Feeding of the fresh pituitary gland to the patients had no effect, and the oral administration of commercial pituitary extract did not modify the diuresis. There was no evidence obtained from any of the tests for kidney function to bear out the contention of Erich Meyer⁴ and others that the diuresis in diabetes insipidus is in any way associated with, or dependent on, a pathologic alteration in the kidneys. Both our patients had perfectly normal phenolsulphonaphthalein excretions. There was no evidence of nitrogen retention in the blood; and when the diuresis was lessened by pituitary extract and the patients were put on a renal test meal their kidneys showed ample ability to concentrate the urine. These clinical observations bear out in the main the findings which we have reported in another case.¹

In these two cases the condition was chronic, of long standing and of unknown etiology. A third case (C.V.) was studied in which the polyuria, apparently associated with a lesion of the base of the brain, came on suddenly, and disappeared after lumbar puncture.

CASE 3.—C. V., male, married, aged 28, was admitted to the Lakeside Hospital medical service, Nov. 27, 1920.

Past History.—This patient had had the ordinary diseases of childhood, and typhoid fever when about 11 years of age (?). At 25 years he had pneumonia, and for some time after was weak. He was thought to have tuberculosis of the lungs at that time and was advised to go to California, which he did. He came back apparently in good health, and then had influenza in February, 1920.

Present Illness.—April 29, 1920, after moving his household effects, at which he had worked very hard, riding around most of the day in a truck, he felt numb over the whole left side of his body. He said that he felt as if the left side of his body belonged to someone else. He was totally unable to move his left arm and hand and also his left leg. This paralysis disappeared in about two hours. It had never appeared prior to that time.

Since the attack of influenza and paralysis the patient enjoyed good health until last night (November 26) at 4 a. m., when he awakened with a dull headache, which he had not had for two years at least, and a slight vertigo, both of which persisted until today (November 27). As he awoke last night he says he had a most extreme sense of thirst in the interior of his nose and not in his mouth. He has since emphasized the fact that the thirst was in his nose and very intense. He also noticed that he had a markedly overfull bladder, which caused him pain above the pubic crest. When he voided urine he said he was sure that he passed more than a quart. His thirst persisted all day yesterday and is still present today in the same intensity. Yesterday he voided from 12 to 14 quarts of urine, and he says that he is maintaining the same average of urine output today. Today he feels weak and tired, in addition to his other complaints, and has a general soreness over his abdomen, which he attributes to his frequently overdistended bladder.

4. Meyer, Erich: *Deutsch. Arch. f. klin. Med.* **83**:1, 1905; *Ztschr. f. klin. Med.* **74**:352, 1912.

Physical Examination.—The patient is an intelligent young man, well proportioned and of healthy appearance. There were no abnormalities about the head, eyes, ears, nose and throat, except those detailed under the neurologic examination. There were a few enlarged lymph glands and a moderate uniform hypertrophy of the thyroid gland. Aside from a slight impairment in the movement of the left upper chest, the examination of the lungs was negative. The heart showed no evidence of enlargement or valvular defect. The pulse was not accelerated; systolic blood pressure was 125, diastolic, 80. The abdomen was normal and an examination of the rectum, genitalia and extremities revealed nothing abnormal.

Neurologic Examination.—The mentality of the patient is good and he cooperates well. Cranial Nerves: There was a loss of the sense of smell in the left side of the nose. The gross vision not impaired. There was a concentric limitation of the left visual field. The left pupil reacts more slowly to accommodation than the right. The external muscles of the eye were normal. There was impairment in the sense of touch and pain over the left forehead and zygomatic area. The lower and lateral part of face were unaffected. There was slight paresis of the left facial nerve. There was a diminution in both bone and air conduction in the left ear. There was impairment in the sense of taste and common sensation on the posterior third of the tongue, but muscles of palate and pharynx seemed intact. There was some atrophy of the left side of the tongue.

Sensory Examination.—There was a very gross impairment in all sensations over much of the left side of the body. This included primarily touch, but there was a corresponding diminution to pain, heat and cold and to vibration. The areas which were most markedly involved were the left forehead, left zygomatic area, left neck, left finger tips, distal phalanx of all toes on the left foot and the medial surface of left leg, etc. There was no ataxia; gait and station normal, and no impairment in complemental opposition; muscles were normal. Both skin and deep reflexes were apparently normal. There was nothing made out to suggest any involvement of the sympathetic nervous system.

Our conclusion from the neurologic examination was that the patient had a basilar lesion which was either a tumor or a serous meningitis.

Urine.—The urine was pale, with a specific gravity of 1.005. The urine never contained any pathologic elements.

Blood.—Blood examination showed hemoglobin, 100 per cent. (Tallquist); white blood cells, 7,000; red blood cells, 5,800,000.

Spinal Fluid.—About 8 c.c. of clear colorless fluid was removed by lumbar puncture. It contained 2 cells to the field; no increase in pressure or in the globulin content. The Wassermann was negative. Blood Wassermann was also negative.

Head.—Roentgenograms of the area about the base of and of the whole skull were negative.

Kidneys.—Phenolsulphonephthalein excretion was 57 per cent. in two hours, and a renal test meal, given after the diuresis had subsided, showed that the kidneys had ample ability to concentrate the urine.

Discharge Note.—This patient had polyuria for less than three days. It made its appearance early in the morning of November 27, and November 29 a lumbar puncture was done for diagnostic purposes, after which the polyuria disappeared, even though nothing pathologic was found in the spinal fluid and there was no increase in pressure. The patient, while the polyuria existed, excreted about 12 liters of urine per day. He had a severe headache for several days following the lumbar puncture. He was discharged from the hospital Dec. 7, 1920. His urine output had not exceeded 1,300 c.c. in any twenty-four hours after the lumbar puncture. There were no demonstrable changes in the neurologic signs on discharge.

Case 3 was one of severe polyuria of very acute onset. There was evidence that the patient had an intracranial lesion which was probably located at the base of the brain. It had apparently involved the olfactory nerve, the optic nerve peripheral to the chiasma and the fifth, seventh, ninth and twelfth cranial nerves, the involvement probably being nuclear, with, perhaps, also some encroachment on the sensory areas in the thalamic region. Our impression was that there was either a tumor or a serous meningitis at the base. A lumbar puncture was decided on for aid in diagnosis. Although the cerebrospinal fluid was not under increased pressure and its examination was negative, after this procedure the increased thirst and diuresis disappeared. In Case 1 lumbar puncture was also done, but there was no effect on the thirst or diuresis.

There has been no return of the diuresis since C. V. (Case 3) left the hospital, and for some months he appeared to be in good health. However, after from three to four months, he began to show signs of loss of mental balance, the derangement taking largely a religious turn, and he had to be discharged from his work. He is now (October, 1921) in a sanitarium, suffering from "nervous breakdown."

Any hypothesis which we could advance as to the cause of the polyuria in this case would be mere conjecture. The course of the onset, the recovery following the lumbar puncture and the fact that there has probably been no increase in the neurologic signs since he left the hospital, make the diagnosis of serous meningitis seem the most likely. Herrick⁵ reported a case in 1912 in which the polyuria ceased after lumbar puncture, and in 1918 Cammidge⁶ reported a case. Cammidge thought his patient had a serous meningitis due to a parasyphilitic state.⁷

It had been intended to study the blood in the same way as in the other cases. But owing to the disappearance of the polyuria after lumbar puncture only two sufficient samples of blood were obtained, one before abstention from water was begun and the other one hour after the taking of water had been resumed. The first specimen was secured on the day when lumbar puncture was done and the second on the following day when the diuresis had already subsided. The conductivity of the serum (Table 3) in the second sample was somewhat greater than in the first and the percentage of serum was somewhat less. The blood specimen obtained at the end of the twenty-four hour period of abstention was so small that only a hematocrit determination could be made. The percentage of serum after thirty-eight minutes rotation was 45, whereas in the sample taken before

5. Herrick: *Arch. Int. Med.* **10**:1 (July) 1912.

6. Cammidge, P. J.: *Practitioner* **105**:244, 1918.

7. We desire to express our thanks to Dr. R. G. Pearce, Akron, Ohio, for referring Case 3 to us for study.

abstention it was 49 after twenty-five minutes rotation. Probably, therefore, there was some diminution in the serum percentage at the end of the period of abstention. At any rate there was no increase. It is impossible from the hematocrit determination alone to say more than this.

SUMMARY

The regulation of the excretion of water by the kidneys was studied in two cases of diabetes insipidus presenting the typical features, and in one case of polyuria of acute onset, apparently associated with a brain lesion. In the last case the polyuria disappeared permanently after lumbar puncture, but the patient eventually developed symptoms of mental derangement.

Blood specimens obtained immediately before and immediately after a long period of complete deprivation of water (twenty-four hours or more) showed no definite differences in the electrical conductivity of the serum, which could be associated with changes in the rate at which water was being absorbed, transported and excreted, although the conductivity can be measured with great accuracy. The same was true of the percentage volume of serum.

Comparison of blood specimens procured within half an hour, and again after five or six hours, after the resumption of water drinking with the specimens obtained just before or just at the end of the period of water deprivation also revealed differences in the conductivity of the serum so slight and so inconstant that it was impossible to connect them definitely with changes in the intake of water.

The percentage of serum, in the observations which we were able to carry out completely, seemed to be somewhat greater in the specimens taken after five or six hours, than in the specimens taken half an hour after resumption of water drinking.

The regulation of the concentration of electrolytes in the plasma and of the relative volume of plasma and corpuscles in the blood was, therefore, at any rate as fine in these cases of diabetes insipidus, in spite of the great variations induced in the quantity of water transported, as in normal persons. It is possible, indeed, that in this condition the renal excretory mechanism is even less tolerant than normal of any excess of water in the blood, or the tissues less capable than normal of storing an excess of water.

As in the case previously published,¹ no evidence was obtained that the condition was associated with any pathologic change in the kidneys. The various tests of efficiency of renal function gave normal results. When pituitary extract was administered the kidney showed normal power of concentrating the urine.