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CLINICAL SIGNIFICANCE OF BLOOD SUGAR IN NEPHRITIS AND OTHER DISEASES *

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INTRODUCTION

Chemical examination of the blood is becoming more and more important in the clinical study of disease. Particularly is this true in those diseases in which the primary disturbance is one of perverted metabolism, of which diabetes mellitus and nephritis are the most common examples. The study of the sugar content of the blood in this field has attracted the attention of many workers, and there have appeared in the literature numerous contributions dealing with the significance of blood sugar and the various problems which it presents.

The studies thus far reported as to the clinical significance of blood sugar have been too few in number and too limited in character for the subject to be dismissed as one clearly elucidated. Moreover, certain methods of investigation have recently been proposed which appear to be worthy of statistical confirmation. For these reasons we propose in this study to present our observations and conclusions from a clinical study of blood sugar in a series of cases of diabetes, nephritis and other miscellaneous, but less important, disorders of body metabolism.

METHODS

In our studies on the sugar content of the blood, we have made use of the Myers¹ modification of the Lewis-Benedict² method for the determination of blood glucose. For the qualitative determination of urinary sugar, we have

* These studies were made in the Hahnemann Hospital, Rochester, N. Y., in which there is, under the direction of one of us, a hospital unit for the study of diseases of metabolism. This unit consists of a group of rooms in one ward and a well equipped special diet kitchen in charge of a trained dietitian. In conjunction with the hospital, there is a complete set of clinical and research laboratories, including a laboratory for work in pathologic chemistry.

† Working under the W. D. Ellwanger Fellowship in Pathological Chemistry.

1. Myers, V. C., and Bailey, C. V.: J. Biol. Chem. **24**:147, 1916.

2. Lewis, R. C., and Benedict, S. R.: J. Biol. Chem. **20**:61, 1915.

employed Benedict's³ Qualitative Solution, and to quantitate, we have made use both of the polariscope and Benedict's⁴ Quantitative Method.

The cholesterol determinations were made by Bloor's⁵ method (Bloor II, so-called). The blood urea was determined by Van Slyke and Cullen's⁶ modification of Marshall's urease method, while Folin's⁷ method was employed in our creatinin investigations. Our uric acid determinations were made by the Benedict-Hitchcock⁸ modification of the Folin-Macallum method, employing the technic recommended by Bogert.⁹

We used Van Slyke's¹⁰ apparatus for measuring the carbon dioxid combining power of blood plasma, and determined the carbon dioxid content of the alveolar air by means of the Frederica apparatus. We employed the Tycos instrument in obtaining our blood pressure values.

STUDIES ON NORMALS

Normal Blood Sugar Values.—Many workers have studied this interesting problem and have obtained varying results. These variations can be accounted for partly because of the methods employed and partly because some of the supposed "normals" were not normal. This is particularly true in the early work on this subject. Strouse¹¹ states that there are no fixed normal values for blood sugar, but that these vary within certain limits with individual peculiarities and diet. Hopkins,¹² using the Bang micromethod, obtained figures ranging from 0.06 to 0.11 per cent. with an average of 0.085 per cent. He quotes the work of Bing and Jacobsen, using the same method, who noted normal values of from 0.06 to 0.12 per cent. Gettler and Baker¹³ in their study of the blood in 30 normal individuals, employing the original Lewis-Benedict method, found the percentage of sugar varying from 0.05 to 0.11 per cent. Cummings and Piness,¹⁴ using a modification of the Lewis-Benedict micromethod of analysis, obtained much lower values, ranging from 0.04 to 0.12 per cent., with an average of 0.07 per cent. Myers and Bailey¹⁵ made observations on 500 cases, and state that most determinations made on individuals with no known cause for hyperglycemia show values from 0.09 to 0.11 per cent. and that a considerable number of hospital patients exhibit values from 0.12 to 0.14 per cent. Joslin¹⁶ speaks of normal values between 0.06

3. Benedict, S. R.: J. Biol. Chem. **5**:485, 1909.

4. Benedict, S. R.: J. Biol. Chem. **9**:57, 1911.

5. Bloor, W. R.: J. Biol. Chem. **24**:229, 1916.

6. Van Slyke, D. D., and Cullen, G. E.: J. Biol. Chem. **19**:219, 1914.

7. Folin, O.: J. Biol. Chem. **17**:479, 1914.

8. Benedict, S. R., and Hitchcock, E. H.: J. Biol. Chem. **20**:619, 1915.

9. Bogert, L. J.: J. Biol. Chem. **31**:165, 1917.

10. Van Slyke, D. D., Stillman, E., Cullen, G. E., and Fitz, R.: J. Biol. Chem. **30**:289, 1917.

11. Strouse, S.: Johns Hopkins Bull. **26**:214, 1915.

12. Hopkins, A. H.: Am. J. M. Sc. **149**:254, 1915.

13. Gettler, A. O., and Baker, W.: J. Biol. Chem. **25**:217, 1916.

14. Cummings, R., and Piness, G.: Arch. Int. Med. **19**:727, 1917.

15. Myers, V. C., and Bailey, C. V.: J. Biol. Chem. **24**:152, 1916.

16. Joslin, E. P.: Treatment of Diabetes Mellitus, 1917, p. 727.

and 0.11 per cent., with most observations about 0.10 per cent. Dennis, Aub and Minot¹⁷ obtained values of from 0.85 to 0.11 per cent., using the Myers¹ modification of the Lewis-Benedict² method.

We also have endeavored to study the blood sugar values in normals. A series of thirty-nine young adults of both sexes in active life, who on careful physical and clinical examination appeared to be in good health, were selected for the blood-sugar tests. For purpose of emphasis, it may be said that all were urine sugar-free. The examinations were made at intervals of from one to six hours after the previous meal. The blood sugar values ranged from 0.07 to 0.15 per cent. In twenty-nine cases the values were 0.11 per cent. or less, while nine cases ranged from 0.12 to 0.14 per cent. One case had 0.15 per cent. The average of the series was 0.11 per cent. As a group there was no well marked relationship between the time of eating and the blood sugar level.

In addition to these, we have made observations on seventy-four other normals, the blood sugar values varying from 0.07 to 0.14 per cent., the average being 0.106 per cent. Thus we have examined in all, 113 normal individuals whose blood sugars averaged 0.107 per cent. Further, we have made blood sugar determinations on sixty miscellaneous cases not diabetes or nephritis, including gastro-intestinal disorders, pernicious anemia, etc. The range of values in these cases was from 0.07 to 0.16 per cent., with an average of 0.115 per cent. We have not sufficient data on any of these diseases to make an arbitrary statement as to the blood sugar findings, but it may be of interest that in four observations on two cases of cirrhosis of the liver, the readings were high normal or slightly elevated, varying from 0.12 to 0.16 per cent. In the light of Benedict and Lewis'¹⁸ statement that the blood sugar is increased in cancer, in five out of ten observations on nine cases of carcinoma, we found a moderate elevation, 0.12 to 0.16 per cent. In a series of twenty-two cases of miscellaneous infections, the range was from 0.07 to 0.15 per cent., with an average of 0.11 per cent.

BLOOD SUGAR IN NEPHRITIS

A number of workers have studied the blood sugar in nephritis. Hopkins,¹² using Bang's micromethod, studied a series of twenty-six patients, many of whom were evidently seriously ill. The blood sugar was normal in only five cases. The others showed a definite but moderate hyperglycemia.

In sixteen cases with a systolic blood pressure ranging from 180 to 280 mm. the blood sugar was normal in only five cases. The others

17. Dennis, W., Aub, J. C., and Minot, A. S.: *Arch. Int. Med.* **20**:964, 1917.

18. Benedict, S. R., and Lewis, R. C.: *Med. Rec.* **77**:650, 1914.

showed a definite but moderate hyperglycemia. In ten cases without high blood pressures, seven had normal blood sugars and three showed hyperglycemia. In the series the blood sugar ranged from 0.06 to 0.159 per cent.

Myers and Bailey¹ report a series of 33 blood sugar observations on 11 cases of severe nephritis. In 21 observations on 7 cases of interstitial nephritis (all fatal but one) the blood sugar ranged from 0.10 to 0.22 per cent. There was no glycosuria in these cases. In 10 observations on 10 cases of the parenchymatous type, the blood sugar varied from 0.14 to 0.20 per cent. These cases exhibited a mild glycosuria. In their experience generally, high blood sugar accompanied high urea, though in one case of parenchymatous nephritis with a blood sugar ranging from 0.17 to 0.20 per cent., the blood urea values were well within the normal limits, 22 mg. and 30 mg. per 100 c.c.

Myers and Killian¹⁹ in a report of twenty-three cases of nephritis state that the blood sugar values vary from 0.11 to 0.32 per cent., with an average of 0.157 per cent. They conclude that in general, high blood sugar values accompany high blood urea values.

Mason²⁰ states that the renal threshold is elevated in acute nephritis and reports that in one case after the ingestion of 100 gm. of glucose the blood sugar values in hourly periods were as follows: 0.10, 0.18, 0.217, 0.17 and 0.11 per cent. There was no urinary sugar.

We have studied in all 50 patients with cardiorenal disease, on whom we have made 88 blood sugar observations. The range of blood sugar levels was from 0.06 to 0.25 per cent., varying directly with the severity of the renal disease. Indeed, we are led to group our nephritis cases into three classes with reference to blood sugar content. In the early stages of interstitial or parenchymatous nephritis, when the general metabolism of the body is but little disturbed, blood sugars as a rule are normal. In the last stage of the disease, when the patient is in uremia, the blood sugar will be found very high, often equaling the blood sugar levels of severe diabetes. Other important metabolic constituents of the blood will also be found correspondingly increased, the whole presenting a picture of complete metabolic failure. A third group of cardiorenal cases, characterized by high blood pressure and little or no evidence of renal disturbance, usually exhibits high blood sugar levels. It is quite probable, as has been suggested by many workers, that some disturbance in the suprarenal bodies or other endocrinal glands is responsible both for the high blood pressure and the increased blood sugar. We were not able to throw light on this phase of the question. In general, it may be said

19. Myers, V. C., and Killian, J. A.: *J. Biol. Chem.* **29**:179, 1917.

20. Mason, E. H.: *Arch. Int. Med.* **21**:216, 1918.

that high blood sugar levels are associated with the severe phases of cardiorenal disease. These patients often excrete small quantities of sugar in the urine, although there appears to be no such quantitative relationship between food intake and urine sugar outgo as obtains in diabetes. Furthermore, the blood sugar level is inappreciably influenced by carbohydrate restriction in the diet. The practical significance of these facts is that such cases are often subjected to the discomfort of rigorous diabetic treatment, which is without effect either on the blood sugar level or the elimination of reducing substances in the urine.

TABLE 1.—COMPARISON OF BLOOD SUGAR LEVELS WITH OTHER CLINICAL DATA RELATING TO KIDNEY FUNCTION IN CASES OF CHRONIC DIFFUSE NEPHRITIS OF MILD AND MODERATE SEVERITY

No.	Sex	Age	Range of Blood Sugar, per Cent.	Range of Blood Pressure		Range of Blood Urea, Mg. per 100 C.c.	Phthalein Output, per Cent.	Ambard Coeffi- cient
				Systolic	Diastolic			
1879	M	37	0.08-0.13	110-70	85-50	30-89	48	0.301
2196	M	59	0.09-0.13	160-150	90	57-106	25	
2270	M	30	0.10	180	120	86		
2438	M	52	0.11	190	100	118-123	25	0.401
2064	F	42	0.11	200	110	74		
2179	M	74	0.08	175	90	41		
2419	M	24	0.10	150-170	110-120	42-58	....	0.255
2220	M	13	0.10	115	80	50-77	....	0.137

TABLE 2.—COMPARISON OF BLOOD SUGAR LEVELS WITH OTHER CLINICAL DATA RELATING TO KIDNEY FUNCTION IN CASES OF CHRONIC DIFFUSE NEPHRITIS OF SEVERE TYPE

No.	Sex	Age	Range of Blood Sugar, per Cent.	Range of Blood Pressure		Range of Blood Urea, Mg. per 100 C.c.	Phthal- ein Output, per Cent.	Ambard Coefficient	Out- come
				Systolic	Diastolic				
1946	F	50	0.09-0.25	140-210	80-110	99-461	2.5-18	0.13	Dead
2143	F	46	0.13-0.20	180-240	100-140	188-277	3	0.68-2	Dead
2152	M	25	0.09-0.12	145-220	100-180	55-228	....	0.29-0.19	Dead
2156*	M	25	0.08-0.15	210-220	160-190	81-255	....	.....	Dead
2243	M	45	0.18-0.20	170-180	90-105	353-492	....	.....	Dead
2144	M	34	0.12-0.18	225	125	114-242	....	0.68	Dead
1690	M	54	0.14	130-180	70-130	89†	7-10	.....	Dead
WC1	F	56	0.22	.....	.....	270	....	.....	Dead
WC2	M	55	0.14	.....	.....	132-196	....	0.49	?

* This case separately discussed.

† Nonprotein nitrogen.

These patients (Table 1) were mildly sick clinically. It will be noted that the blood ureas and the Ambard coefficients of urea concentration are but moderately increased. Blood pressures, both systolic and diastolic, do not indicate a very serious disturbance. Blood sugar levels in each instance are normal. Disturbance in nitrogen metabolism precedes the rise in blood sugar.

These patients (Table 2) were all critically ill. In some instances the observations were made in the terminal stage of the disease. The high blood pressures, the severe albuminuria, extreme nitrogen reten-

tion, two-hour renal studies, high Ambard coefficients, etc., all indicate serious impairment of kidney function. In each of these cases the failure in nitrogen metabolism preceded the rise in the blood sugar level, the latter only becoming high in the critical stage of the nephritis.

These cases (Table 3) were all characterized by severe general edema, severe albuminuria, normal or moderately elevated blood pressures, little or no evidence of nitrogen retention and normal blood sugars. The high blood sugar determinations in cases 1669, 1960 and 1816 were obtained when the patients were moribund and probably represent terminal failure of metabolism.

TABLE 3.—COMPARISON OF BLOOD SUGAR LEVELS WITH OTHER CLINICAL DATA RELATING TO KIDNEY FUNCTION IN A SERIES OF CHRONIC PARENCHYMATOUS NEPHRITIS OF THE SEVERE TYPE

No.	Sex	Age	Range of Blood Sugar, per Cent.	Range of Blood Pressure		Range of Blood Urea, Mg. per 100 C.c.	Phthalein Output, per Cent.	Outcome
				Systolic	Diastolic			
2460	M	40	0.11	140-170	120-130	30-83	....	Dead
2226	F	23	0.11-0.11	150	100-105	39-85	59	Living
1669	M	59	0.14	180-225	100-130	67	23-55	Dead
2298	M	17	0.10-0.10	138	80	38-128	58	Living
2266	F	39	0.11	110-150	85-90	21-46	28	Living
1960	F	67	0.08-0.18	140-150	80	41-95	12	Dead
1816	M	54	0.13-0.20	210-240	130-160	64-92	22	Dead

TABLE 4.—COMPARISON OF BLOOD SUGAR LEVELS WITH OTHER CLINICAL DATA RELATING TO KIDNEY FUNCTION IN A SERIES OF CASES OF CARDIOVASCULAR DISEASE

No.	Sex	Age	Range of Blood Sugar, per Cent.	Range of Blood Pressure		Range of Blood Urea, Mg. per 100 C.c.	Phthalein Output, per Cent.	Outcome
				Systolic	Diastolic			
2110	F	52	0.12	200	100	45	....	Living
2170	F	73	0.16	169-206	85-100	38	....	Living
1829	M	51	0.12	170-200	100-120	40	41	Living
1853	F	56	0.11	200-240	110-120	31-40	....	Living
2263	M	44	0.12-0.13	180-210	110-140	30-43	....	Living
1429	M	51	0.11	180-220	130-150	40-56	22-30	Dead
2176	M	53	0.10-0.15	150-180	120	23-61	....	Dead
2358	F	54	0.11	200-220	130-140	40-77	23	Living
2398	M	48	0.11	200-230	140-170	37-79	14-13	Living
2154	M	63	0.10	160-180	80-100	31-45	....	Living
1988	F	60	0.10	.....	.....	68	35	Living
2225	M	66	0.10	190-240	.....	83	....	Living
1633	F	49	0.12	140-190	100-120	34	46-70	Living
2440	F	54	0.12-0.23	170-220	115-140	43-19	46-70	Living
2185	M	53	0.20	160	90-110	41-51	43	Living

These cases (Table 4) are characterized by very severe hypertension, slight or no albuminuria, and little or no nitrogen retention. They all exhibit normal blood sugars except case 2176, in which the high observation was made when the patient was moribund, and cases 2170, 2185 and 2440, whom we believe from other clinical evidence to have some endocrinal disturbance. Case 2440 we have studied in detail. Clinically, Cases 2110, 2263, 1829 and 1633 seem to be in the early stages of this same endocrinal type.

TABLE 5.—CASE 1946. COMPARATIVE BLOOD ANALYSES IN A FATAL CASE OF CHRONIC DIFFUSE NEPHRITIS IN THE BEGINNING AND TERMINAL STAGES

Date 1917	Blood Analysis					Urine Analysis		Diet			
	Urea, Mg. per 100 C.c.	Creat- inin, Mg. per 100 C.c.	Choles- terol, Mg. per 100 C.c.	Ambard Coeff- icient	Sugar, per Cent.	Sugar	Albu- min	Pro- tein, Gm.	Fat, Gm.	Car- bohy- drate, Gm.	Calo- ries
6/12 1918	99.4	10.2	189	0.13	0.09	0	+++	30	77	137	1,471
4/11	348.9	10.0	....	.....	0.15	0	++	33	22	74	680
4/12	323.2	11.1	158	.....	0.25	0	++	33	22	74	680
4/18	460.5	16.1	....	.....	0.25	0	0	33	22	74	680

CASE 1 (No. 1946).—Woman, aged 50; nephritis, probably of less than one year's duration. Blood pressure at time of first examination, systolic 150 mm., diastolic 90 mm. Clinical symptoms at first comparatively mild with moderate elevation of blood urea and normal blood sugar. High blood creatinin portended fatal outcome. The blood analyses made ten months later and just before death reveal a severe failure of nitrogen metabolism and an accompanying rise in blood sugar. It is noteworthy that nitrogen retention preceded the failure in sugar metabolism. The patient's urine was sugar-free. The renal blood sugar threshold in this case was more than 0.25 per cent. (Table 5).

TABLE 6.—CASE 2144. COMPARATIVE BLOOD ANALYSES IN A SEVERE CASE OF CHRONIC DIFFUSE NEPHRITIS

	Blood Analysis					Urine Analysis			Diet			
Date 1917	Urea, Mg. per 100 C.c.	Creat- inin, Mg. per 100 C.c.	Choles- terol, Mg. per 100 C.c.	Ambard Coeff- icient	Blood Plasma CO ₂ , C.c. per 100 C.c.	Sugar, per Cent.	Sugar	Albu- min	Pro- tein, Gm.	Fat, Gm.	Car- bohy- drate, Gm.	Calo- ries
9/17	242.0	8.8	128	.....	40.9	0.18	0	+++	32	32	64	640
9/25	114.2	10.6	160	0.68	30.0	0.14	0	+++	38	38	76	760
9/27	.....	12.2	...	.....	30.0	0.12	0	+++	32	32	64	640

CASE 2 (No. 2144).—Man, aged 34; nephritis of seven years' standing. Blood pressure, systolic 225 mm., diastolic 120 mm. On admission to hospital there was severe general edema and dyspnea. Blood examinations showed evidence of extreme metabolic failure in the high urea and sugar. High creatinin and low plasma carbon dioxid portended fatal outcome. On Karrell diet, noteworthy clinical improvement with disappearance of edema and dyspnea accompanied by a sharp decline in blood urea and sugar. Patient left hospital in good condition but succumbed to pneumonia one month later (Table 6).

CASE 3 (No. 1816).—Man, aged 54; clinical evidence of severe arteriosclerosis over a period of two years. Blood pressure, systolic ranging from 220 to 250 mm., diastolic 110 to 140 mm. Data in Table 7 represents the terminal stage of the disease. Attention is called to the slight nitrogen retention and the slightly elevated blood sugars. At the time of the last test, the patient was critically ill, edema and dyspnea were very pronounced. This case illustrates the probable degree of metabolic failure in the terminal stage of chronic parenchymatous nephritis.

CASE 4 (No. 2156).—Man, aged 25; had been a chronic alcoholic for eight years; admitted to hospital in delirium and coma two weeks before death. Blood pressure, systolic 210 mm., diastolic 160 to 190 mm. Note (Table 8) the comparatively slight failure of nitrogen metabolism on admission and the rapid change to a condition of marked retention before death. These findings are paralleled by the blood sugar curve. The absence of severe acidosis as

shown by the blood plasma curve is noteworthy in this case. Necropsy findings: The kidneys presented very little gross evidence of disease. On section there was a moderate degree of connective tissue in the cortex, some sclerosis of the blood vessels and a little patchy calcification in the tubules. The medullary rays were but a little affected. The brain was extremely edematous and hemorrhagic.

TABLE 7.—CASE 1816. COMPARATIVE BLOOD ANALYSES IN A PATIENT WHO, IN THE EARLY STAGES OF THIS STUDY, PRESENTED CLINICAL EVIDENCE OF GENERAL ARTERIOSCLEROSIS AND RENAL SCLEROSIS, LATER DEVELOPING SIGNS OF PARENCHYMATOUS NEPHRITIS WITH SEVERE ALBUMINURIA AND EDEMA AND SLIGHT NITROGEN RETENTION. FATAL TERMINATION THREE MONTHS AFTER LAST ANALYSIS

Date 1917	Blood Analysis						Urine Analysis		Diet			
	Urea, Mg. per 100 C.c.	Creat- inin, Mg. per 100 C.c.	Uric Acid, Mg. per 100 C.c.	Ambar- d Coeff- cient	Blood Plasma CO ₂ , C.c. per 100 C.c.	Sugar, per Cent.	Sugar	Albu- min	Pro- tein, Gm.	Fat, Gm.	Car- bohy- drate, Gm.	Calo- ries
10/16	67.21	4.2	.....	0.24	48.1	0.14	0	+++	32	32	64	640
10/25	65.78	3.6	7.97	.....	53.2	0.14	0	+++	39	38	134	1,031
11/ 5	64.64	2.5	6.90	.....	.....	0.13	0	+++	67	75	136	1,176
11/19	92.95	.....	.....	.....	50.9	0.20	0	+++	61	126	225	2,292

TABLE 8.—CASE 2156. COMPARATIVE BLOOD ANALYSES IN A FATAL CASE OF CHRONIC ALCOHOLISM AND CHRONIC DIFFUSE NEPHRITIS

Date 1917	Blood Analysis						Urine Analysis		Diet			
	Urea, Mg. per 100 C.c.	Creat- inin, Mg. per 100 C.c.	Uric Acid, Mg. per 100 C.c.	Choles- terol, Mg. per 100 C.c.	Blood Plasma CO ₂ , C.c. per 100 C.c.	Sugar, per Cent.	Sugar	Albu- min	Pro- tein, Gm.	Fat, Gm.	Car- bohy- drate, Gm.	Calo- ries
10/16	80.8	2.8	.....	192	52.8	0.08	0	++++	16	16	32	320
10/19	82.9	3.7	.....	.....	48.1	0.10	0	++++	25	25	68	580
10/24	254.5	6.2	13.0	.....	50.3	0.15	0	++++	6	0	0	30
10/27	230.2	7.0	.....	.....	50.5	0.15	0	+	5	2	19	99

TABLE 9.—CASE 2143. COMPARATIVE BLOOD ANALYSES IN THE TERMINAL STAGES OF A FATAL CASE OF CHRONIC DIFFUSE NEPHRITIS

Date 1917	Blood Analysis							Urine Analysis		Diet			
	Urea, Mg. per 100 C.c.	Creat- inin, Mg. per 100 C.c.	Uric Acid, Mg. per 100 C.c.	Choles- terol, Mg. per 100 C.c.	Ambar- d Coeff- cient	Blood Plasma CO ₂ , C.c. per 100 C.c.	Sugar, per Cent.	Sugar	Albu- min	Pro- tein, Gm.	Fat, Gm.	Car- bohy- drate, Gm.	Calo- ries
9/29	188.8	6.2	....	...	....	38.5	0.14	0	+++	32	32	64	640
10/ 3	....	9.1	11.2	240	....	32.3	0.16	0	++	32	32	64	640
10/ 4	140.1	8.9	11.5	...	0.68	34.3	0.13	0	++	32	32	64	640
10/11	231.7	13.9	13.2	201	1.99	29.1	0.19	0	+++	39	37	107	903
10/19	277.4	12.8	....	...	....	24.1	0.20	0	++++	2	1	54	436

CASE 5 (No. 2143).—Woman, aged 46; blood pressure, systolic 230 mm., diastolic 140 mm.; extensive edema; severe dyspnea. The failure of nitrogen metabolism (Table 9) was more serious and preceded the failure in sugar metabolism. High renal blood sugar threshold. Necropsy findings: kidneys, gross examination, small, contracted. On section the cortex exhibited an extreme degree of fibrosis and granulation tissue which had obliterated a

generous percentage of the parenchymatous structures. Many of the glomeruli were scarred while those remaining had a varying degree of sclerosis in the tufts. The dilated convoluted tubules contained degenerate necrotic epithelium. The blood vessels showed an extreme grade of hyaline necrosis, particularly in the intima, almost to the point of obliteration. Marked cloudy swelling and fatty degeneration of the liver and suprarenal bodies were present.

CONCLUSIONS

1. The average digestion blood sugar level in 113 normal individuals was 0.107 per cent., the values ranging from 0.07 to 0.14 per cent.

2. The range of the blood sugar level in a series of sixty cases of miscellaneous diseases, chiefly gastro-intestinal disorders and pernicious anemia, excluding diabetes, nephritis and infections, was from 0.07 to 0.16 per cent., with an average of 0.115 per cent.

3. In a series of nine cases of carcinoma there was a moderate elevation of blood sugar, 0.12 to 0.16 per cent.

4. In a series of twenty-two miscellaneous infections, chiefly influenza, pneumonia, and streptococcus, the range was from 0.07 to 0.15 per cent., with an average of 0.11 per cent.

5. In the early stages of nephritis, when the general metabolism of the body is but little disturbed, blood sugars, as a rule, are normal.

6. In the last stages of nephritis, when the patient is in uremia, the blood sugar will be found very high, often equalling the severe stages of diabetes. Other important metabolic constituents of the blood will be found correspondingly increased, presenting a picture of complete metabolic failure.

7. A third group of cardiovascular cases, characterized by high blood pressure and little or no evidence of renal disturbance, usually exhibits blood sugar levels slightly higher than normal.

8. In severe cases of nephritis, patients may excrete small quantities of sugar in the urine, frequently giving rise to the misapprehension that true diabetes exists. In such cases the blood sugar level is inappreciably influenced by carbohydrate restriction, and these patients should not be subjected to the discomfort of rigorous diabetic diet.

9. Failure in nitrogen metabolism precedes, often by months, the rise in blood sugar, so that the latter has a rather serious prognostic omen.

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