

SUGAR TOLERANCE IN DEMENTIA PRAECOX AND OTHER MENTAL DISORDERS

W. F. LORENZ, M.D.

MADISON, WIS.

Normally during a fasting period the blood sugar maintains a fairly constant level. The figures for normal persons obtained by various investigators are: Bang,¹ 0.10 per cent.; Myers and Bailey² (500 cases), 0.09 to 0.11 per cent.; Williams and Humphrey³ (thirty-nine cases), 0.11 per cent. and (seventy-four cases) 0.107 per cent.; Liefman and Stern,⁴ 0.105 per cent. Weston,⁵ in a series of mental cases, found a blood sugar content ranging from 0.085 to 0.122 per cent., figures well within normal limits.

The blood sugar content may vary from a variety of causes. Not only does diet affect the sugar concentration but, according to Lusk⁶ and Strouse,⁷ variations were seemingly associated with the season of the year. Emotional states are likewise associated with changes in blood sugar concentration. Such effects were demonstrated in some of our cases. This is in accord with the observation of glycosuria during excitement by Cannon⁸ and by Bohm and Hoffman⁹ following painful stimulation of animals.

We, therefore, decided to note the emotional state, to insist on a preparatory period of fasting for at least twelve hours, and to have the patient maintain a recumbent position in bed under conditions of comfortable room temperature.

A normal reaction following the feeding of 100 gm. of glucose is as follows: During the first one-half hour the blood sugar rises and attains its highest level between one-half and one hour after the feeding. This rise is rarely more than from 0.04 to 0.05 per cent. Following the rise

1. Bang, I.: *Der Blutzucker*, Wiesbaden, 1913.

2. Myers and Bailey: *J. Biol. Chem.* **24**:152, 1916.

3. Williams, J. R., and Humphrey, E. M.: *Arch. Int. Med.* **23**:537, 1919.

4. Liefman and Stern: *Biol. Chem. Ztschr.* **1**:301, 1906.

5. Weston, Paul G.: *Analyses of Blood of Insane Patients*, *Arch. Neurol. & Psychiat.* **3**:147 (Feb.) 1920.

6. Lusk, G.: *Elements of the Science of Nutrition*, Ed. 2, Philadelphia, W. B. Saunders Company, 1910.

7. Strouse, S.: *Observations on Alimentary Hyperglycemia*, *Arch. Int. Med.* **26**:759 (Dec.) 1920.

8. Cannon, W. B.: *Bodily Changes in Pain, Fear, Hunger and Rage*, New York, D. Appleton & Co., 1920.

9. Bohm and Hoffman in Cannon: *Bodily Changes in Pain, Fear, Hunger and Rage*, New York, D. Appleton & Co., 1920.

during the first hour there is a gradual fall until the concentration reaches its initial level, usually in from two and one-half to three hours after the feeding.

The earlier investigations of sugar tolerance were made in diseases in which disturbance of carbohydrate metabolism is the chief manifestation. Patients with diabetes gave a decidedly abnormal response after a glucose meal. The blood sugar rose slowly but reached a high concentration between the first and second hour after feeding. The rise was far above the normal and the high concentration was maintained over a much longer period. The initial level was rarely approached at the end of the third hour. In some cases a high concentration was maintained from four to five hours.

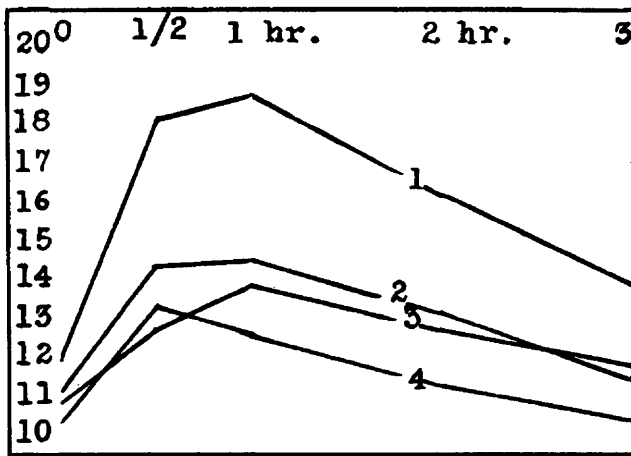


Chart 1.—The average curves of (1) catatonic patients, (2) hebephrenic patients, (3) patients with simple deteriorating praecox, and (4) patients with paresis.

Diabetes shows the highest blood sugar concentration in any disease so far reported and may reach 0.3 per cent.

A person with hyperthyroidism has also been shown to respond differently than a normal person, by Hamman and Hirschman,¹⁰ Janney and Isaacson,¹¹ Geyelin,¹² Cummings and Pines,¹³ Pemperton and Foster,¹⁴ and others. In this condition the blood sugar following a sugar meal rises rapidly and reaches its highest concentration usually within the first hour; this high point averages above 0.2 per cent. During the succeeding two and one-half hours the blood sugar gradually

10. Hamman, L., and Hirschman, I. I.: *Arch. Int. Med.* **20**:176, 1917.

11. Janney, N. W., and Isaacson, V. I.: *Arch. Int. Med.* **22**:160, 1918.

12. Geyelin, H. R.: *Arch. Int. Med.* **16**:975, 1915.

13. Cummings, R. I., and Pines, G.: *Arch. Int. Med.* **19**:777, 1917.

14. Pemperton, R., and Foster, G. L.: *Arch. Int. Med.* **25**:243, 1920.

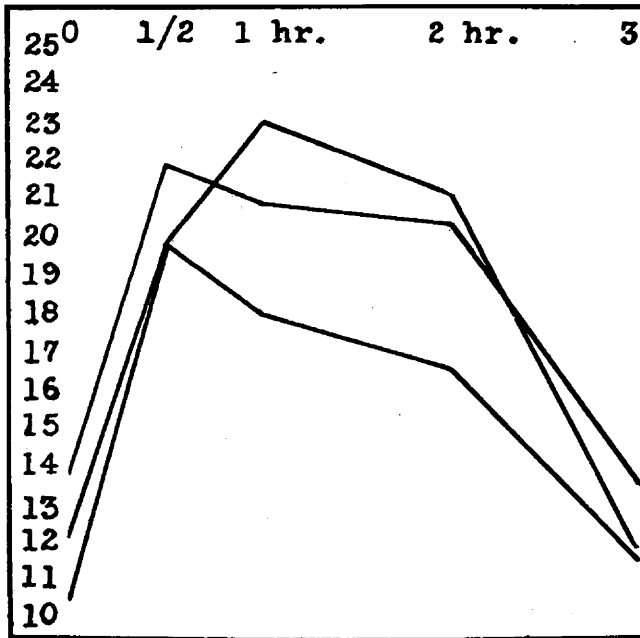


Chart 2 (Case C4).—This chart shows the similarity of response in one case of catatonia—three examinations at intervals of over four weeks.

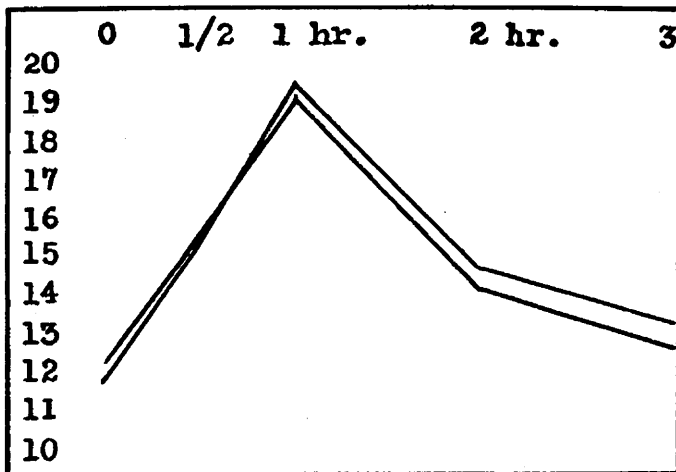


Chart 3 (Case C9, Catatonia).—Close parallelism in results of two examinations made at intervals of two weeks.

falls and approaches the initial level at the end of the third hour. These two types of response to sugar feeding are found in conditions of relatively low sugar tolerance; both show glycosuria after carbohydrate feeding. Patients with diseases of the pituitary gland and hypothyroid states show high sugar tolerance. The characteristic of this group is a reaction curve of less than normal as reported by Brock and Kaw,¹⁵ Janney, Goodhart and Isaacson,¹⁶ McCrudden and Sargent,¹⁷ Knopfmacher,¹⁸ and others.

It may therefore be regarded as well established that certain endocrine disturbances are rather constantly associated with disturbance of carbohydrate metabolism; furthermore, that disturbance of carbohydrate metabolism can be demonstrated by tests of sugar tolerance, using as a method of investigation the hyperglycemia which follows a glucose meal.

The association of endocrine activity with mental development and mental states after maturity, the prominent rôle claimed for the endocrine glands in carbohydrate metabolism and the variations from normal reactions in clear endocrine dysfunctions, already quoted, suggested the use of this test to investigate internal gland disturbance in certain mental diseases.

Kooy, quoting W. F. Menzies,¹⁹ reported that patients with melancholia show an abnormal response in the blood sugar for a two hour period following breakfast. Other than this we have found only an occasional case of mental disease, one parietic and several epileptic cases included among the cases reported by other investigators.

TECHNIC OF TEST

The work here reported began in November, 1920. A large series of blood examinations was made in which the method of Myers-Bailey²⁰ was compared with Benedict's modification²¹ of the Lewis-Benedict method. It was decided to use the latter in our investigation.

Glucose was administered in 50 per cent. solution flavored with lemon juice and chilled with ice. The dose was 1.75 gm. per kilo of body weight. The feeding was given in the morning after fasting for from twelve to fourteen hours. All subjects were kept in bed

15. Brock, S., and Kaw, W. E.: *Arch. Int. Med.* **27**:1, 1921.

16. Janney, N. W.: Goodhart, S. P., and Isaacson, V. I.: *Arch. Int. Med.* **21**:188, 1917.

17. McCrudden, F. H., and Sargent, C. S.: *Arch. Int. Med.* **17**:465, 1916.

18. Knopfmacher, W.: *Wien. klin. Wchnschr.* **17**:244, 1904.

19. Menzies, W. F.: *J. Ment. Sc.* **64**:275, 1920.

20. Myers and Bailey: *J. Biol. Chem.* **24**:147, 1916.

21. Benedict: *Benedict's Modification of the Lewis and Benedict Method*, *J. Biol. Chem.* **34**:203, 1918.

throughout the period of the test. Urine examinations were made on specimens voided during the three hours of observation. Approximately 3 to 4 c.c. of blood were taken from a vein and oxalated at once in a test tube. One sample was taken a few minutes before feeding the glucose. Subsequent samples were taken one-half hour, one, two and three hours after the glucose meal. Bedside notes were made on the emotional state, muscular activity, etc. The blood samples were all examined shortly after they were obtained, and the results are given in grams per cent.

TABLE 1.—GLUCOSE TEST IN CASES OF DEMENTIA PRAECOX.
HEBEPHRENIC TYPE

Case No.	Before Feeding	½ Hour Interval	1 Hour Interval	2 Hour Interval	3 Hour Interval	Total Rise	Period of Rise
Q 1	0.094	0.125	0.145	0.122	0.12	0.051	1 hour
	0.102	0.136	0.158	0.140	0.11	0.056	1 hour
D 2	0.122	0.150	0.132	0.120	0.115	0.028	½ hour
D 3	0.110	0.146	0.115	0.115	0.102	0.036	½ hour
D 4	0.100	0.130	0.128	0.128	0.122	0.030	½ hour
D 5	0.100	0.126	0.138	0.130	0.121	0.038	1 hour
D 6	0.095	0.137	0.128	0.101	0.094	0.042	½ hour
D 7	0.126	0.155	0.145	0.136	0.129	0.029	½ hour
D 8	0.100	0.146	0.155	0.135	0.116	0.055	1 hour
D 9	0.105	0.110	0.128	0.120	0.110	0.023	1 hour
D10	0.100	0.147	0.140	0.114	0.099	0.047	½ hour
D11	0.110	0.149	0.141	0.139	0.110	0.039	½ hour
D12	0.095	0.160	0.150	0.100	0.100	0.065	½ hour
D13	0.125	0.130	0.148	0.144	0.140	0.023	1 hour
D14	0.108	0.116	0.108	0.120	0.104	0.018	2 hours
D15	0.112	0.120	0.151	0.140	0.120	0.039	1 hour
D16	0.100	0.165	0.150	0.125	0.102	0.055	½ hour
O17	0.100	0.148	0.134	0.122	0.103	0.048	½ hour
D18	0.105	0.130	0.125	0.110	0.105	0.025	½ hour
D19	0.110	0.128	0.147	0.160	0.110	0.040	2 hours
D20	0.135	0.163	0.142	0.120	0.131	0.028	½ hour
D21	0.124	0.146	0.133	0.130	0.146	0.059	1 hour
D22	0.127	0.136	0.160	0.175	0.120	0.052	2 hours
D23*	0.120	0.210	0.150	0.146	0.130	0.030	½ hour
D24*	0.100	0.160	0.175	0.145	0.085	0.075	1 hour
D25*	0.140	0.148	0.182	0.130	0.132	0.048	1 hour
Average	0.110	0.143	0.144	0.131	0.114	0.043	

* Females.

MATERIAL STUDIED

In all, 107 cases of mental disease were studied. Of this number, eighteen occurred in females. The mental diagnosis was made after a period of observation extending over several months. An effort was made to include cases that showed characteristic pictures. Of these 107 cases, 52 were diagnosed as dementia praecox, 17 as manic-depressive insanity, 7 as paresis and 3 as morphinism. The remaining 24 included feeble-mindedness, epilepsy, alcoholism, involution melancholia, hyperthyroidism and a number of clinically obscure cases.

Our interest centered largely on the dementia praecox cases. The fifty-two cases in this group were subclassified into twenty-five hebephrenic, eleven catatonic, seven simple deteriorating and nine paranoid types.

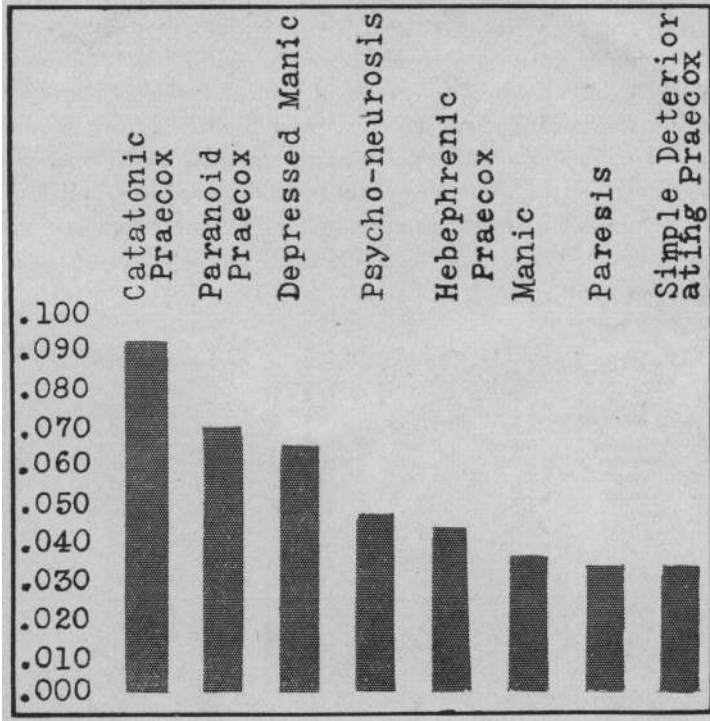


Chart 4.—Diagrammatic representation of average maximum rise of blood sugar in the various conditions noted. Horizontal line at .045 represents the average normal rise.

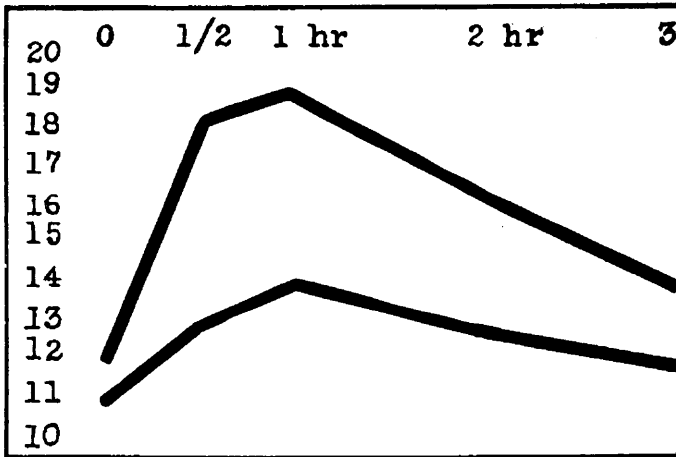


Chart 5.—The upper curve represents the average reaction in catatonic cases. The lower curve shows the average reaction in simple deteriorating dementia praecox.

DEMENTIA PRAECOX

The response to sugar feeding was practically normal in the hebephrenic type. The initial blood sugar concentration after a twelve hour fast was uniformly higher in the catatonic patients than in those with other forms of dementia praecox. The average initial level of the catatonic patients was 0.120 per cent. as compared to 0.110 per cent. for the hebephrenic patients and 0.108 per cent. for those with the simple

TABLE 2.—GLUCOSE TESTS IN CASES OF DEMENTIA PRAECOX, PARANOID TYPE

Case No.	Before Feeding	½ Hour Interval	1 Hour Interval	2 Hour Interval	3 Hour Interval	Total Rise	Period of Rise
P D 1	0.130	0.183	0.165	0.145	0.130	0.053	½ hour
P D 2	0.150	0.215	0.185	0.180	0.175	0.065	½ hour
P D 3	0.125	0.150	0.125	0.126	0.128	0.025	½ hour
P D 4	0.130	0.210	0.165	0.138	0.136	0.080	½ hour
P D 5	0.160	0.212	0.163	0.160	0.150	0.052	½ hour
P D 6	0.106	0.150	0.126	0.125	0.115	0.045	½ hour
P D 7	0.12	0.182	0.165	0.134	0.125	0.062	½ hour
P D 8*	0.145	0.165	0.210	0.186	0.144	0.065	1 hour
P D 9*	0.11	0.135	0.130	0.115	0.115	0.023	½ hour
Average	0.130	0.179	0.175	0.155	0.136	0.065	

* Females.

TABLE 3.—GLUCOSE TESTS IN CASES OF CATATONIC DEMENTIA PRAECOX

Case No.	Before Feeding	½ Hour Interval	1 Hour Interval	2 Hour Interval	3 Hour Interval	Total Rise	Period of Rise
C 1	0.118	0.218	0.140	0.130	0.121	0.100	½ hour
C 2	0.10	0.194	0.116	0.108	0.098	0.094	½ hour
C 3	0.127	0.188	0.210	0.180	0.144	0.083	1 hour
C 4	0.095	0.166	0.131	0.121	0.100	0.071	½ hour
C 5	0.12	0.185	0.245	0.252	0.24	0.132	2 hours
C 6	0.105	0.198	0.180	0.165	0.115	0.088	½ hour
C 7	0.121	0.196	0.230	0.212	0.124	0.109	1 hour
C 8	0.138	0.218	0.208	0.204	0.135	0.080	½ hour
C 9	0.108	0.166	0.214	0.165	0.106	0.106	1 hour
C 10	0.142	0.215	0.230	0.185	0.170	0.088	1 hour
C 11	0.106	0.135	0.206	0.145	0.115	0.100	1 hour
C 12	0.118	0.162	0.210	0.210	0.130	0.092	1 hour
C 13	0.140	0.265	0.220	0.165	0.142	0.125	½ hour
C 14	0.106	0.145	0.193	0.162	0.145	0.087	1 hour
C 15	0.118	0.152	0.195	0.146	0.134	0.077	1 hour
C 16	0.121	0.152	0.192	0.140	0.126	0.071	1 hour
C 17	0.120	0.160	0.135	0.125	0.115	0.040	½ hour
C 18	0.110	0.140	0.13	0.12	0.12	0.030	½ hour
C 19	0.130	0.160	0.255	0.224	0.15	0.125	1 hour
Average	0.118	0.179	0.191	0.166	0.133	0.089	

deteriorating type of disease. The average maximum rise of blood sugar following the glucose meal in the catatonic patients was over 0.20 per cent., in the hebephrenic 0.14 per cent. and in the simple deteriorating type 0.13 per cent. The increase of blood sugar for the catatonic patients averaged 0.094 per cent., while for the hebephrenic and simple deteriorating types the average was between 0.025 and 0.033 per cent.

LORENZ—SUGAR TOLERANCE IN DEMENTIA PRAECOX 191

The paranoid type, of which there were nine cases, also showed a reaction above normal. The average initial level was 0.130 per cent. The high point averaged 0.159 per cent., and the total increase above initial level averaged 0.046 per cent.

Of the dementia praecox group, therefore, the catatonic patients clearly showed an abnormal response that closely resembled the curve obtained in hyperthyroidism.

TABLE 4.—GLUCOSE TESTS IN CASES OF DEMENTIA PRAECOX, SIMPLE DETERIORATING TYPE

Case No.	Before Feeding	½ Hour Interval	1 Hour Interval	2 Hour Interval	3 Hour Interval	Total Rise	Period of Rise
S D 1	0.092	0.091	0.096	0.095	0.088	0.004	1 hour
S D 2	0.098	0.090	0.096	0.098	0.088	0.000	
S D 3	0.122	0.132	0.140	0.140	0.135	0.018	1 hour
S D 3	0.097	0.146	0.145	0.110	0.110	0.049	½ hour
S D 4	0.115	0.134	0.130	0.152	0.125	0.065	1 hour
S D 5	0.100	0.115	0.153	0.151	0.132	0.053	1 hour
S D 6	0.105	0.141	0.123	0.112	0.102	0.036	½ hour
S D 7	0.115	0.132	0.130	0.125	0.122	0.017	½ hour
Average	0.105	0.122	0.133	0.122	0.113	0.034	

TABLE 5.—GLUCOSE TESTS IN CASES OF PARESIS

Case No.	Before Feeding	½ Hour Interval	1 Hour Interval	2 Hour Interval	3 Hour Interval	Total Rise	Period of Rise
P 1	0.121	0.143	0.108	0.110	0.106	0.022	½ hour
P 2	0.094	0.105	0.130	0.105	0.10	0.036	1 hour
P 3	0.103	0.131	0.120	0.107	0.103	0.028	½ hour
P 4	0.086	0.127	0.130	0.110	0.093	0.044	1 hour
P 5	0.094	0.142	0.132	0.112	0.102	0.048	½ hour
P 6	0.113	0.151	0.130	0.117	0.111	0.038	½ hour
P 7	0.106	0.125	0.130	0.125	0.103	0.024	1 hour
Average	0.102	0.132	0.125	0.112	0.102	0.034	

PARESIS

Seven cases of paresis were included in this series. All responded in a strikingly similar manner, the uniformity of the curves being remarkable. The initial level in paresis was 0.101 per cent. The highest concentration after feeding varied from 0.110 to 0.151 per cent. The average for all cases was 0.132 per cent. At the end of the third hour in every case the blood sugar concentration closely approached the initial level. The increase above initial level averaged 0.033 per cent. The response in patients with paresis thus tends to be somewhat less than the normal.

MANIC-DEPRESSIVE INSANITY

Of this group, six males and four females were in a manic phase. The initial, fasting blood-sugar level ranged from 0.102 to 0.126 per cent. and averaged 0.111 per cent. The maximum rise occurred during the first hour and reached an average of 0.145 per cent. The increase above the initial level averaged 0.035 per cent. This response is less

than normal. The individual variation from the average response among these cases was not great.

Seven depressed cases were tested. The initial blood sugar level varied from 0.082 to 0.122 per cent., the average being 0.106 per cent. The maximum concentration after feeding occurred during the first hour and averaged 0.154 per cent. The increase was approximately 0.05 per cent., which is greater than the normal response. Our findings, therefore, tend to corroborate the observations reported by Kooy.¹⁹

TABLE 6.—GLUCOSE TESTS IN CASES OF MANIC-DEPRESSIVE INSANITY, MANIC PHASE

Case No.	Before Feeding	½ Hour Interval	1 Hour Interval	2 Hour Interval	3 Hour Interval	Total Rise	Period of Rise
Males							
M 1	0.114	0.12	0.132	0.13	0.105	0.018	1 hour
M 2	0.10	0.14	0.132	0.105	0.092	0.04	½ hour
M 3	0.122	0.16	0.162	0.13	0.115	0.04	1 hour
M 4	0.112	0.158	0.14	0.132	0.12	0.046	½ hour
M 5	0.12	0.142	0.164	0.15	0.126	0.044	1 hour
M 6	0.104	0.13	0.15	0.125	0.112	0.046	1 hour
Average	0.112	0.141	0.146	0.128	0.111	0.039	
Females							
M 7	0.11	0.133	0.144	0.13	0.112	0.034	1 hour
M 8	0.107	0.141	0.115	0.102	0.102	0.034	½ hour
M 9	0.102	0.142	0.135	0.115	0.096	0.04	½ hour
M 10	0.126	0.157	0.153	0.136	0.128	0.031	½ hour
Average	0.111	0.143	0.136	0.120	0.109	0.034	

TABLE 7.—GLUCOSE TESTS IN CASES OF MANIC-DEPRESSIVE INSANITY, DEPRESSED PHASE

Case No.	Before Feeding	½ Hour Interval	1 Hour Interval	2 Hour Interval	3 Hour Interval	Total Rise	Period of Rise
M D 1	0.082	0.094	0.136	0.100	0.083	0.054	1 hour
M D 2	0.098	0.150	0.142	0.137	0.120	0.032	½ hour
M D 3	0.110	0.125	0.193	0.138	0.107	0.083	1 hour
M D 4	0.120	0.202	0.164	0.130	0.135	0.082	½ hour
M D 5	0.100	0.164	0.140	0.133	0.127	0.064	½ hour
M D 6	0.122	0.140	0.165	0.120	0.125	0.043	1 hour
M D 7	0.114	0.147	0.162	0.152	0.132	0.048	1 hour
Average	0.106	0.146	0.157	0.130	0.118	0.060	

PSYCHONEUROSIS

In this group there were five cases. The average initial blood sugar level was 0.108 per cent. The maximum concentration averaged 0.151 per cent. and the increase averaged 0.047 per cent. This response is approximately normal.

MORPHINISM

Three cases of morphinism are included in this series. The tests were made before drug withdrawal in two patients, T 1 and T 2, who had received one-half grain of morphin (0.03 gm.) on the evening previous

to the test. They were fairly comfortable in the morning and presented no withdrawal symptoms. These two patients responded to the sugar tests in a decidedly abnormal manner. The initial blood sugar concentration was 0.134 and 0.145 per cent. After the sugar meal the blood sugar concentration rose rapidly to a high level. At the one-half hour interval both showed a concentration well above 0.2 per cent. At the hour interval one patient showed 0.3 per cent. During the succeeding two hours the blood sugar fell rapidly but had not returned to its initial level at the end of the third hour. The increase above the initial level in case T 1 was 0.157 per cent. and in case T 2 0.093 per cent. The third case is of interest. At the time of the sugar meal this patient complained bitterly of withdrawal pains. No morphin was given. The initial blood sugar concentration was 0.175 per cent., which is extremely high. After the feeding the concentration did not change but maintained the initial high level for approximately two and one-half hours, and at the end of the third hour was slightly below it.

TABLE 8.—GLUCOSE TESTS IN CASES OF PSYCHONEUROSES

Case No.	Before Feeding	½ Hour Interval	1 Hour Interval	2 Hour Interval	3 Hour Interval	Total Rise	Period of Rise
P N 1	0.086	0.095	0.126	0.102	0.085	0.040	1 hour
P N 2	0.108	0.117	0.136	0.120	0.103	0.028	1 hour
P N 3	0.120	0.135	0.156	0.144	0.123	0.036	1 hour
P N 4	0.100	0.162	0.140	0.132	0.102	0.062	½ hour
P N 5	0.130	0.140	0.200	0.151	0.126	0.070	1 hour
Average	0.108	0.129	0.151	0.129	0.107	0.047	

TABLE 9.—GLUCOSE TESTS IN CASES OF MORPHINISM

Case No.	Before Feeding	½ Hour Interval	1 Hour Interval	2 Hour Interval	3 Hour Interval	Total Rise	Period of Rise
T 1	0.145	0.224	0.292	0.206	0.156	0.147	1 hour
T 2	0.134	0.215	0.227	0.215	0.194	0.093	1 hour
T 3	0.175	0.175	0.17	0.168	0.166	0.000	

UNCLASSIFIED AND OTHER MENTAL STATES

An additional twenty-five cases were included in our series. These comprised feeb' mindedness, epilepsy, alcoholism, neurasthenia, psychasthenia and a number of clinically doubtful or undetermined cases. It is interesting that of the clinically doubtful cases, in three, in which catatonic dementia praecox was considered (U 11, U 14 and U 18), the response to the test resembled the curve obtained in the frankly catatonic cases, the increase in blood sugar being 0.075, 0.076 and 0.082 per cent., respectively.

DISCUSSION

A considerable number of our patients were tested on several occasions in the course of two or more months; in some cases three

tests were made. The curves obtained on repetition of the tests were strikingly similar. In several cases the parallelism was closely maintained throughout the entire period of three hours. In one case of catatonia, C 11, the first test showed the character of curve obtained in every catatonic case, with the exception of C 10. A second test on C 11, several months subsequent to the first, was practically normal. After the first test this patient improved very much, and at the time of

TABLE 10.—GLUCOSE TEST IN UNCLASSIFIED AND OTHER MENTAL STATES

Case No.	Before Feed-ing	½ Hour Inter-val	1 Hour Inter-val	2 Hour Inter-val	3 Hour Inter-val	Total Rise	Period of Rise	Diagnosis and Remarks
U 1	0.128	0.144	0.152	0.131	0.126	0.024	1 hour	Constitutional inferiority
U 2	0.097	0.116	0.125	0.110	0.102	0.028	1 hour	Feeble-minded
U 3	0.114	0.153	0.136	0.126	0.120	0.039	½ hour	Feeble-minded
U 4	0.123	0.150	0.133	0.125	0.118	0.027	½ hour	Feeble-minded
U 5	0.115	0.120	0.154	0.126	0.120	0.039	1 hour	Feeble-minded epileptic
U 6	0.123	0.130	0.144	0.126	0.114	0.021	1 hour	Epileptic
U 7	0.125	0.080	0.118	0.148	0.100	0.023	2 hours	Epileptic
U 8	0.105	0.138	0.125	0.121	0.115	0.033	½ hour	Alcoholic deterioration
U 9	0.105	0.172	0.165	0.150	0.122	0.067	½ hour	Chronic alcoholism hallucinosis
U 10	0.106	0.173	0.125	0.111	0.108	0.067	½ hour	Chr. alcoholism paranoid
U 11	0.115	0.183	0.190	0.162	0.132	0.075	1 hour	Unclassified manic symptoms; catatonia suspected
U 12	0.140	0.163	0.212	0.165	0.135	0.072	1 hour	Atypical manic
U 13*	0.152	0.195	0.159	0.142	0.145	0.043	½ hour	Neurasthenia and hyperthyroidism
U 14	0.100	0.162	0.176	0.147	0.080	0.076	1 hour	Dementia praecox with manic symptoms, possibly catatonic
U 15	0.098	0.205	0.222	0.125	0.085	0.124	½ hour	Psychasthenia
	0.105	0.200	0.195	0.132	0.114	0.095	½ hour	
U 16	0.132	0.131	0.187	0.165	0.112	0.055	1 hour	Involution melancholia
U 17	0.125	0.173	0.135	0.126	0.118	0.048	½ hour	Unclassified, possibly depressive manic
U 18	0.124	0.140	0.206	0.140	0.132	0.082	1 hour	Dementia praecox, possibly catatonic
U 19	0.110	0.180	0.120	0.115	0.114	0.070	½ hour	Unclassified atypical manic
U 20	0.108	0.165	0.180	0.115	0.104	0.072	1 hour	Dementia praecox hebephrenic, doubtful
	0.110	0.176	0.180	0.120	0.115	0.070	1 hour	
U 21*	0.101	0.160	0.134	0.121	0.125	0.059	½ hour	Manic-depressive insanity, mixed type
U 22	0.124	0.135	0.176	0.160	0.111	0.052	1 hour	Unclassified questionable dementia praecox
U 23	0.112	0.166	0.121	0.115	0.106	0.054	½ hour	Dementia praecox hebephrenic questionable
	0.115	0.185	0.178	0.127	0.115	0.070	½ hour	
U 24	0.100	0.145	0.138	0.133	0.102	0.045	½ hour	Dementia praecox hebephrenic questionable
	0.104	0.152	0.176	0.155	0.118	0.072	1 hour	

* Females.

the second test was markedly better. He was up and about, talked quite readily, was interested in occupational work and expressed no false ideas, but he had no insight into his former condition.²²

22. Raphael, T., and Parsons, I. P.: Blood Sugar Studies in Dementia Praecox and Manic-Depressive Insanity, Arch. Neurol. & Psychiat. 5:687 (June) 1921. These authors reported, during the period of our investigations, conclusions similar to our own. They found an abnormal sugar tolerance curve in dementia praecox; the depressions gave a high curve and the manic excitements a low response. The number of cases studied by them did not permit conclusions as to types of response in the different subgroups of dementia praecox. The patient in Case 9 of their series gave a very high curve similar to that which we obtained in catatonia.

Owing to lack of cooperation, it was often difficult to collect specimens of urine. We were able, however, to obtain them in over 50 per cent. of our cases. Examinations for sugar were made on all of these specimens. The results were by no means uniform, and we were not able to prove the assertion that a blood sugar concentration of 0.17 per cent. is the threshold of elimination. Many of our patients had a blood concentration above 0.2 per cent. for periods of one hour and more and yet failed to show sugar in the urine.

Assuming that the curves noted in hyperthyroidism are directly the result of altered thyroid function or, secondarily, the expression of disturbance in the endocrine chain, the conclusion that endocrine imbalance exists in catatonia is warranted. Whether this manifestation is due to a primary disturbance of any member of the endocrine system or whether it is merely the expression of altered function due to some emotional state cannot be decided on this evidence.

One case strikingly demonstrates the effect of emotion during the application of the test. Case P. D. 9 was one of paranoid dementia praecox in which ideas of persecution, particularly of poison administration, the use of noxious gases and electricity, were dominant. Shortly after taking the sugar solution the patient expressed fear of a poisonous dose. Later, when the first blood sample was taken, he manifested marked fear; his face was very pale; there was profuse perspiration, rapid breathing and a general picture of great apprehension. In this case the blood sugar rose from an initial level of 0.132 to 0.195 per cent. within one-half hour after feeding and at the hour interval reached 0.318 per cent. Following this high concentration a rapid drop was noted. At the end of the second hour the blood sugar was 0.25 per cent. and at the end of three hours it was 0.145 per cent., only slightly above the initial level. This patient showed the highest response of any in our series. The case of morphinism, T 3, also bears on the effect of emotion on blood sugar. The feeding of glucose in this case caused no response in the blood sugar. In attempting to interpret the abnormal responses found in catatonic dementia praecox, one must hold in mind the possibility that emotional states may exist without being clearly evident. It, therefore, still leaves us in doubt. The possibility of the existence of considerable emotional tension in an active catatonic state with consequent sensitiveness of the suprarenals and thus the possibility of an oversupply of epinephrin and an upset of the endocrine balance, which might be manifested by abnormal reaction to sugar feeding, must be considered.

Another group of patients that tended to show a uniform character of response was that of the seven patients with cases diagnosed as dementia praecox—simple deteriorating type. This subgroup, as usually interpreted, includes cases in which general mental deterioration is

evident without strikingly bizarre ideas or attitudes. Three patients gave responses that clearly simulated the reactions obtained in patients with hypothyroidism and allied conditions of hypofunction. Case SD 1 showed, in two examinations, a blood sugar level that remained low throughout the test, the curve being almost a straight line. SD 2 and SD 7 gave slight responses, the maximum rise in blood sugar in each being less than 0.02 per cent. This group, taken as a whole, gave an average curve which is less than the normal response; the maximum rise was 0.025 per cent. In view of these findings one may suspect that, in some of these cases at least, there is an endocrine dysfunction.

CONCLUSIONS

1. Except in cases of active catatonia, certain cases of simple deteriorating dementia praecox and several cases in which evident emotional upsets existed at the time of the test, this investigation points to a blood sugar concentration in mental disease that is practically normal when the test is made while the patient is fasting, the average being 0.105 per cent.

2. The response of patients with mental cases, except the types mentioned in the foregoing, to sugar feeding is generally within normal range.

3. Patients with active cases of catatonic dementia praecox responded to glucose feeding with a hyperglycemia that resembles the response obtained in hyperthyroidism.

4. Several cases of simple deteriorating dementia praecox responded to glucose feeding in a manner that resembles the responses obtained in certain endocrine disturbances, such as dyspituitarism.

5. Patients with cases of manic-depressive insanity—depressed phase—responded to the sugar test with a curve higher than that found in normal subjects.