

STUDY IN BASAL METABOLISM IN DEMENTIA PRAECOX AND MANIC-DEPRESSIVE PSYCHOSES *

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The idea has long been current that disturbances of metabolism occur in certain mental disorders. Theories of an intoxication, probably endogenous, have often been advanced. Until recently the chemical methods available for clinical application did not afford sufficient evidence to indicate the extent or nature of such disturbances, and there was little to indicate what structures or functions might be involved. The more improved methods of clinical chemistry and the increasing evidence that the ductless glands are involved in many disturbances of growth and metabolism have recently caused a greatly increased interest and activity in the study of such disturbances in patients with mental disease. As a result, there is now some evidence and considerable opinion that disorders of the ductless glands and changes in metabolism may occur in certain psychopathic conditions and psychotic reactions.

Variations in the basal metabolic rate have been found to occur in clinical conditions involving certain ductless glands, especially the thyroid and pituitary. This should, therefore, be a useful method for detecting in psychotic patients disturbances of metabolism in which these glands are involved. Bowman¹ has obtained readings below — 10 per cent. in seven of ten patients with dementia praecox. In five of the seven, the rate had increased to — 10 per cent., or higher, at the end of six months.

The observations we here report were made for the purpose of obtaining some idea as to the relation of the mental state of the patient to the basal metabolic rate, while, at the same time, we endeavored to determine in just what clinical types of psychotic reaction, studies in metabolism may be carried on most profitably and controlled appropriately.

Technic.—The observations were made in rooms on the same floor with the ward occupied by the female patients studied. No food was given after the supper at 5:30 the evening before the tests, and the samples were collected from 9:15 to 11 a. m. The female patients

* From the New York State Psychiatric Institute, and the Medical Clinic, New York Hospital.

1. Bowman, K. M.; Edison, J. P., and Burladge, S. P.: Biochemical Studies in Ten Cases of Dementia Praecox, Boston M. & S. J. **187**:358, 1922.

were kept in bed on the morning of the test, taken to the toilet at 8:30 and then placed in large roller chairs completely recumbent and with sufficient blankets and pillows to insure comfort and warmth. They were then kept under constant observation to secure the necessary rest period and rolled into the room for observation when required. Male patients were dressed, walked down one flight of stairs, across the grounds about 200 yards and up one flight, partially undressed, and placed in the chairs at 8:30.

The apparatus used in determining the basal metabolism was a spirometer of the Tissot type having a capacity of more than 125 liters. Outdoor air was brought into the room by means of a six inch galvanized iron pipe. The inspired and expired air was separated by means of a modified Lovén valve.² A gas mask,³ such as was used by the French Army, was used in the majority of observations in connection with this valve and was found to be more satisfactory than the usual mouthpiece and noseclip, although in many cases both were tried. Not only did the majority of patients have less difficulty in breathing naturally through the mask, many patients almost falling asleep, but the cooperation of the patients became a less important factor so long as they remained physically quiet.

The pulse rate and respiration were counted before, during and after the observation. The average counts are recorded in the tables.

The spirometer was washed out with approximately 15 liters of expired air and the average volume expired per minute was noted. If the patient appeared fairly comfortable and seemed to be breathing naturally, the three-way valve leading to the spirometer was opened at the end of an expiration. The patient was permitted to breathe into the gasometer for six minutes unless the volume expired was abnormally small. In that case the valve was turned off at the end of an expiration after eight minutes. The time was always recorded by a stop-watch. Any physical or mental disturbance on the part of the patient was especially noted.

Samples of air were collected in bottles containing equal parts of glycerin and saturated sodium chlorid solution. The expired air analyses were always done on the day of the observation, with a modification of a Henderson's air analyzer. Analyses of outside air with this apparatus gave averaged values of 0.03 per cent. for carbon dioxide and 20.91 per cent. for oxygen.

2. McCann, W. S.: The Effect of the Ingestion of Foodstuffs on the Respiratory Exchange in Pulmonary Tuberculosis, *Arch. Int. Med.* **25**:850 (July) 1921.

3. Bailey, C. V.: Apparatus Used in the Estimation of Basal Metabolism, *J. Lab. & Clin. M.* **6**:657 (Sept.) 1921.

In determining the values for carbon dioxide and oxygen in expired air, duplicate analyses checked within 0.04 per cent., except in two cases in which the variation was 0.05 per cent.

Selection of Cases.—The more typical cases of dementia praecox, manic-depressive insanity and psychoneurosis were considered as most suitable, and preferably those in the more active and acute phases, provided sufficient cooperation could be had to meet the requirements of the procedure. Each patient was examined from the standpoint of disordered thyroid and other gland function. The more definite findings of this character which might influence the basal rate are noted in Tables 1, 2 and 3. Except to this extent none of the patients was considered to show gland disturbance of the recognized clinical types which would be expected to influence the rate. To what extent the readings may be accounted for in these terms will be discussed later. None of the cases was considered from routine examination to be complicated by organic disease of the nervous system or other organs except the postencephalitic case in the miscellaneous group, and a trace of albumin and a few casts in the urine, at times, in the first case in the manic-depressive group.

The cases were observed on the Psychiatric Institute Service and were carefully considered from the standpoint of clinical grouping by Dr. Geo. H. Kirby, director of the institute.

Cooperation.—The requirements of the test are physical and mental rest and relaxation to secure a basal level. If the physical factor can be secured then variations in the mental factor can be considered in relation to the basal rate. The notes in the tables as to cooperation refer to the physical requirements, primarily the control of motor activity during the test and the preliminary rest period, and to the respiration. The term "satisfactory" designates a degree of physical cooperation comparable to that of the average nonpsychotic patient. In some cases, especially the retarded depressions, there was even less motor activity than normal. In those noted as "restless" there was some shifting or turning in the chair or moving of the head and arms, in some instances accompanied by talking. Further observations are necessary to determine just how much the rate is influenced by the motor activity and such disturbances of respiration as occur in mildly restless patients. In some of the readings the variations of this kind were considered to be so small that the reading could be classed as satisfactory. These readings are noted as satisfactory, but with the addition of notes to indicate the presence of slight variations. Less satisfactory readings are indicated by the notes. Where the reading was quite evidently influenced by motor activity the reading has been enclosed in brackets.

Mental cooperation by psychotic patients to the extent of mental quietness or relaxation in the same sense as in nonpsychotic or non-neurotic patients is of course quite difficult to obtain or even to estimate accurately. The psychic factor, the mental or emotional state or tension, in relation to the basal rate has been considered in two ways, assuming that motor activity is controlled. First, as a separate factor influencing the rate directly, and second, as a part of the total clinical picture of the psychosis. That is, whether the rate would vary with the character and intensity of the mental and emotional state at the precise time of collecting the sample, or would be more closely correlated with the clinical type of psychotic reaction as shown by the symptoms and behavior from day to day. It would now seem that the demonstration of a direct relation between the rate and the mental state at the time would require quite careful psychologic observations and a degree of cooperation which cannot be had from the types of patients who have shown the greatest variation from the normal rate. It would also probably be essential to separate the mental state into several factors including the mental content, or what the patient was thinking about, and the character and intensity of the emotional reaction both subjectively and objectively. A direct psychic or emotional influence on the rate to an extent requiring such observations at the precise time of determining the rate would suggest a considerable degree of lability and responsiveness by the rate to such stimuli. It is of interest here to note the increase in the basal rate following the subcutaneous injection of 0.5 c.c. of epinephrin,⁴ which suggests an increased rate in primitive emotional reactions like fear, as described by Cannon and by Watson. A similar and sustained response of the organism to prolonged emotional stimuli of this kind would, however, seem more problematical. And, unfortunately, the complex emotional factor in psychotic reactions is often quite difficult of estimation and expression in these terms. In the cases here reported the consistency of consecutive readings on the same patient speaks against a responsiveness by the basal rate to any factor which can be considered separately and independently from the total clinical condition from day to day. It remains, therefore, to consider the rate in relation to the clinical reaction types into which the cases fall and what factors or symptoms in the clinical picture it can be correlated with.

MANIC-DEPRESSIVE GROUP

The manic-depressive cases are arranged in Table 1 somewhat according to the basal rate, with the lowest at the top. The first seven cases were typical of depression. The first four cases were recent admissions, and quite comparable clinically, had shown little or no

4. Sandiford: *Am. J. Physiol.* **51**:407, 1920.

TABLE 1.—MANIC-DEPRESSIVE GROUP

	Psycho- motor	Emotional	Date, 1922	Basal Rate, per Cent.	Cooperation	T.	P.	R.	Weight, Lbs.	Height, M.	Surface Area Ht.-Wt. Formula (DuBois)	Volume Expired Liters per Hour	Gas Analysis CO ₂ per Cent.	O ₂ per Cent.	Calo- ries per Hour	R. Q.
No. 1. Depressive; male 53; Adm. 1/31/22; previous attacks, 3; manic type; gradual improvement during period of these observations	Inactive; retarded; quiet	Depressed; looks dis- tressed; no tears	2/15 2/16 2/20 3/20	-13 - 8 -15 -11	Satisfactory Satisfactory Satisfactory Satisfactory	98 98 98 98	60 59 54 54	14 18 19 16	147 147 148 145	1.77	1.82m ² 1.82m ² 1.82m ² 1.81	292.0 279.3 290.5 360.1	3.44 3.42 3.20 3.33 3.33 2.78 2.75	16.87 16.87 16.70 16.68 16.94 16.92 17.60 17.56	59.18 63.04 58.00 60.19	0.809 0.709* 0.795 0.782
No. 2. Depressive; male 29; Adm. 2/4/22; previous attacks, none; no thy- roid signs; thyroid, 2 gr. daily, 3/10; no improve- ment noted	Fairly ac- tive but retarded; quiet; keeps occupied in a slow way	Depressed; sad, dis- tressed ex- pression; many tears	2/24 2/27 3/ 1 3/22	-13 - 9 -12 - 3	Satisfactory Satisfactory Satisfactory Satisfactory	98 98 98 98	48 52 53 48	15 16 15 20	147 147 147 149	1.77	1.82	403.2 426.0 430.8 468.5	2.51 2.50 2.84 2.70 2.70 2.56 2.56	17.82 17.83 17.88 17.90 17.78 18.01 17.96	62.51 64.92 63.23 69.74	0.765 0.919 0.900 0.836
No. 3. Depressive; female 57; Adm. 3/11/22; pre- vious attacks, 2	Inactive; retarded; quiet	Depressed few tears	3/21 3/25	-11 -11	Satisfactory Satisfactory	98 ^a 98 ²	88 82	11-19 17	161.5 162.5	1.64	1.79	348.1 364.3	2.45 2.45 2.41	17.69 17.73 17.89	55.79 55.48	0.714* 0.744
No. 4. Depressive; female 45; Adm. 1/19/22; pre- vious attacks, 3; skin dry, glossy, yellowish, thin; hair dry; brows thin; thyroid, 2 gr. daily 3/12; no definite im- provement noted	Inactive; retarded; quiet; wants to stay in bed	Depressed; sad expres- sion but smiles feebly at times; no tears	2/21 2/23 3/ 2 3/21	- 9 -15 - 8 - 2	Satisfactory Satisfactory Satisfactory Satisfactory	98 98.4 98.2 98	72 72 66 60	12 11 15 15	125 125 123 123.5	1.65	1.61 1.61 1.60 1.60	309.6 272.0 307.9 319.1	2.85 2.84 3.00 3.00 2.79 2.79 2.95 2.94	17.52 17.49 17.35 17.33 17.49 17.48 17.39 17.42	52.82 48.81 52.78 56.17	0.796 0.798 0.771 0.800
No. 5. Depressive; female 33; Adm. 3/27/22; pre- vious attacks, 2	Inactive	Depressed; suicidal	3/29	- 6	Moved several times; after lunch was re- moved and said she was afraid	98	60	16	127	1.68	1.64	357.9	2.69 2.70	17.80 17.77	56.32	0.823
No. 6. Depressive; male 41; Adm. 1/26/22; previous attacks, 1; manic type; improved since adm.	Inactive; quiet; slightly retarded	Depressed; stolid ex- pression; no tears	2/ 2 2/ 6	- 6 - 3	Satisfactory Satisfactory	98.8 98.2	63 62	12 10	149.5 151	1.79	1.84 1.84	323.7 346.4	3.78 3.76 3.69 3.67	16.82 16.84 16.93 16.94	66.48 69.18	0.808 0.902
No. 7. Depressive; post- partum; female 41; Adm. 9/24/21; previous at- tacks, 2, each postpar- tum; now much improv- ed; underweight 15 pounds, but gaining	Inactive; quiet	Depressed; unstable; smiles easily at times	2/ 7 2/11	- 6 + 3	Satisfactory Satisfactory	98.4 98.2	84 78	16 16	86.5 88	1.59	1.34 1.35	229.4 272.4	3.13 3.11 3.21 3.16	16.94 16.97 17.23 17.26	45.28 50.08	0.743 0.885

No. 8. Mixed; female 19; Adm. 1/4/22; previous attacks, none	Usually quiet, outbursts of overactivity; at times mute and semi-stuporous	Marked variability	2/3 2/9	- 6 (+ 9)	Satisfactory	97.2 99	82 88	16 20	98.5	1.67	1.47 1.45	246.5 335.0	3.48 3.49 3.01 3.01	16.68 16.65 17.17 17.18	52.31 62.49	0.781 0.762
No. 9. Manic; now hypomanic; female 33; Adm. 2/11/22; previous attacks, none; thyroid slightly enlarged, nodular	Overactive; restless Less active	Elated; short periods of depression More emotional and tearful at time of last readings	3/7 3/9 4/20 4/21	- 8 -15 + 7 + 5	Satisfactory Satisfactory Satisfactory Satisfactory	98.6 98.8 98.8 98.6	57 63 72 73	14 16 13 13	97 97 120 120	1.61	1.42 1.42 1.55 1.55	219.2 266.2 316.8 316.3	3.62 3.61 3.14 3.13 3.13 3.13 3.11	16.58 16.56 17.60 17.64 17.12 17.12 17.18	47.66 44.15 60.43 59.16	0.794 0.835 0.779 0.791
No. 10. Manic; now hypomanic; female 19; Adm. 11/8/21; previous attacks, one	Overactive	Mild elation	2/16 2/21 2/28	- 6 + 1 - 8	Restless before test; quiet during test Restless before test; quiet during test Satisfactory	98.8 98.8 98.4	70 106 72	25 24 28	128 126 124.5	1.55	1.55 1.54	380.6 396.5 381.6	2.40 2.41 2.42 2.44 2.37 2.41	18.02 18.04 17.93 17.94 18.12 18.10	55.10 59.30 53.69	0.793 0.774 0.813
No. 11. Circular; now hypomanic; female 48; Adm. 4/17/19; previous attacks, one; depression postpartum	Overactive	Elated; irritable	2/16	- 3	Satisfactory	98.2	58	16	174	1.67	1.87	290.3	3.63 3.62	16.44 16.42	65.06	0.766
No. 12. Manic; now hypomanic; female 19; Adm. 2/25/22; previous attacks, one, circular	Overactive	Elated	3/4 3/7	+ 4 - 1	Restless before and during test; moved hands some Restless before and during test	98.2 98	69 58	12 13	148 144.5	1.56	1.66 1.64	315.6 299.2	3.24 3.26 3.31 3.32	16.75 16.76 16.78 16.80	65.41 61.61	0.735 0.762
No. 13. Mixed; female 30; Adm. 7/21/17; agitated; previous attacks, 3	Overactive; agitated	Depressed, with anxiety and apprehension	3/14 3/16	+ 6 + 2	Restless, apprehensive; pulse and respiration constant Restless, apprehensive; pulse and respiration constant	98 99.4	72 63	12 20	118.5 118	1.53	1.49	356.6 359.7	2.66 2.64 2.81 2.81	17.69 17.71 17.85 17.83	57.40 55.49	0.782 0.886
No. 14. Depressive; agitated; male 41; Adm. 10/11/21; previous attacks, none	Overactive; muscle tonus increased; agitated	Depressed; distressed; sad, agitated	2/24 2/27	+ 5 + 7	Satisfactory Satisfactory; hand clenched	98 98	70 92	16 18	126 127	1.72	1.67	408.4 440.7	3.05 3.05 2.74 2.73	17.58 17.58 17.78 17.80	67.51 69.07	0.889 0.843
No. 15. Mixed; now hypomanic; female 39; Adm. 10/28/21; previous attacks, 3; thyroid palpable, not enlarged; much improved since admis.	Overactive; works all day	Constantly elated and smiling	3/11 3/21	+35 +20	Satisfactory Satisfactory	98.6 98.6	102 88	15 17	107 111	1.58	1.47 1.49	426.5 391.6	2.92 2.89 2.76 2.77	17.52 17.53 17.62 17.58	72.36 64.94	0.819 0.796

* 0.720 used for calculations.

TABLE 2.—DEMENTIA PRAECOX GROUP

	Date, 1922	Basal Rate, per Cent.	Cooperation	T.	P.	R.	Weight, Lbs.	Height, M.	Surface Area Ht.-Wt. Formula (DuBois)	Volume Expired Liters per Hour	Gas Analysis		Calo- ries per Hour	R. Q.
											CO ₂ Cent.	O ₂ Cent.		
No. 16, Male 17; Adm. 2/4/22; depressive; delusional; quiet; apprehensive, fearful; soon after became actively suicidal on delusional basis, requiring restraint and constant watching; slightly emaciated; pale; Hgb. 85%; history of very rapid growth	2/10	-25	Satisfactory, apprehensive and nervous	98	76	19	90	1.64	1.40m ²	211.2	3.25 3.26	16.65 16.62	45.10	0.72
	2/14	-32	Satisfactory, somewhat apprehensive	98	60	21	90	....	....	220.0	3.09 3.08	17.21 17.22	40.74	0.792
	2/15	-24	Satisfactory, apprehensive	98	66	19	91	....	....	226.3	3.40 3.38	16.87 16.87	45.85	0.708
No. 17, Female 16; Adm. 10/28/20; catatonic type; usually mute; wets and soils at times; eats ravenously; well nourished; childish appearance; sex development retarded, has menstruated only one time; thyroid full, possibly slightly enlarged; Pulse 120-130 at times	2/ 3	(+ 9)	Not satisfactory, tried to sit up	99	112	16	91	1.59	1.37	369.6	2.80 2.79	17.28 17.28	59.79	0.722
	2/ 9	-17	Satisfactory	98	96	16	90.5	....	....	286.9	2.63 2.63	17.73 17.74	45.55	0.787
	2/11	-23	Satisfactory	98	84	15	88.4	....	1.35	236.5	2.95 2.94	17.38 17.41	41.72	0.797
No. 18, Female 19; Adm. 1/31/22; hebephrenic type; childish appearance; wets and soils; bed wetter for past two years; profane; thyroid slightly and uniformly enlarged; amenorrhea since admission	3/11	-21	Fairly satisfactory; talked at end but volume remained constant	98.2	60	19	100	1.49	1.37	278.1	2.64 2.64	17.99 18.01	40.7	0.877
	3/29	(-10)	Not satisfactory, moved constantly, talked	97.4	60	16	96.5	....	1.34	268.0	2.76 2.77	17.47 17.49	46.06	0.761
No. 19, Male 20; Adm. 2/28/22; catatonic; mute; inactive; spoon fed; increased muscle tonus; prison record	3/ 6	-10	Satisfactory	98.4	60	12	118.5	1.73	1.63	318.6	2.90 2.90	17.37 17.37	56.48	0.775
	3/ 8	-17	Satisfactory	98.8	60	11	118.5	....	....	303.7	2.97 2.97	17.38 17.34	53.64	0.803
	3/28	- 5	Satisfactory	99.4	80	18 Irreg.	114.5	....	1.61	348.4	2.84 2.80	17.45 17.43	60.62	0.796
Before last reading symptoms became more pronounced; tube fed; muscle tonus greatly increased														
No. 20, Female 36; Adm. 2/25/21; paranoid, depressive; depressed; not definitely agitated; overactive, constantly at work	3/14	-16	Not satisfactory; restless, afraid, crying before test; quiet 15 min. before and during test	97.4	59	26	96.5	1.51	1.35	310.5	2.62	18.29	41.23	0.965

No. 21. Female 26; Adm. 11/9/21; paranoid type; usually quiet and inactive; perplexity, emotional variability; objective symptoms improved since admission	3/18	-13	Fairly satisfactory, apprehensive; pulse and respiration regular and normal	97.4	48	18	97	...	1.36	246.7	2.79 2.77	17.40 17.42	43.17	0.747
	2/3	-16	Fairly satisfactory; quiet; uneasy; wanted to hold breath	98.2	80	12	97	1.61	1.42	192.5	3.75 3.77	16.31 16.34	44.11	0.779
	2/9	(+ 9)	Not satisfactory; restless; respiration uneven	98.6	80	13	97.5	...	...	289.2	3.45 3.46	16.98 16.96	57.18	0.842
	2/16	-4	Satisfactory	98.6	72	12	97.5	...	...	287.8	2.90 2.90	17.39 17.38	50.80	0.750
	3/2	-9	Satisfactory; restless before test	98.4	64	17	92.7	...	1.40	246.3	3.18 3.15	17.13 17.13	46.72	0.798
No. 22. Male 19; Adm. 2/28/22; paranoid type; quiet; apprehensive	3/6	-12	Satisfactory	99	60	20	120	1.08	1.60	321.5	2.36 2.34	17.28 17.92	59.05	0.730
	3/8	-9	Satisfactory, somewhat restless before test	99.2	68	26	118	...	...	449.3	2.17 2.17	18.27 18.28	59.30	0.781
No. 23. Male 17; Adm. 12/28/21; paranoid type; inactive; quiet; partial insight; improved since admission	3/3	-5	Satisfactory	98	72	14	129.5	1.61	1.60	336.3	3.37 3.38	17.03 17.08	65.16	0.840
	3/13	-10	Satisfactory	98.8	60	11	129.5	...	...	320.4	3.53 3.52	17.10 17.09	61.57	0.898
No. 24. Male 16; Adm. 9/29/21; hebephrenic type; admitted after episode of excitement; improved since admission; now seclusive; smiling; marked cyanosis and sweating of hands	2/6	-5	Satisfactory	98.2	76	12	119.5	1.64	1.58	277.6	4.07 4.09	16.29 16.33	64.05	0.855
	2/10	-8	Satisfactory	98	72	17	122	...	...	291.5	3.65 3.69	16.61 16.66	62.21	0.819
No. 25. Male 28; Adm. 5/1/21; paranoid type; overactive; euphoric; psychopathic; criminal history	2/15	+12	Fairly satisfactory; quiet; uneasy; fingers moved constantly during test	98	80	13	114.5	1.66	1.56	284.3	4.28 4.28	16.07 16.08	68.87	0.854
No. 26. Male 21; Adm. 1/7/22; paranoid type; periods of overactivity and excitement; first reading followed and last reading just preceded these disturbed periods	2/2	+16	Satisfactory	98.2	81	16	123	1.68	1.62	342.6	3.40 3.43	16.60 16.59	73.82	0.747
	2/8	+11	Satisfactory	98	74	15	122	...	1.61	304.3	3.77 3.77	16.25 16.27	70.62	0.768
	3/15	+17	Satisfactory	98	79	18	115	...	1.58	435.7	2.84 2.84	17.54 17.58	73.29	0.807

improvement when these observations were started, cooperated well, and showed rather consistent readings which averaged -11.2 per cent. The fifth patient did not cooperate well. The sixth and seventh patients were much improved and showed readings more nearly normal. In Case 9 the manic attack was accompanied by considerable loss of weight. The first readings, -8 and -15 per cent., respectively, were made soon after the patient was quiet enough to cooperate. There was rapid improvement with gain in weight. The last readings were made just as the patient was ready to go home, and were $+7$ and $+5$ per cent. respectively.

In Case 15 there were no very definite signs of hyperthyroidism, although the readings were $+35$ and $+20$ per cent. Since admission the emotional reaction has been objectively quite marked. At first she cried easily and showed a flushed face, and is now quite definitely and genuinely elated.

Two patients (Cases 13 and 14) showed the agitated type of depression, but cooperated sufficiently well to indicate that their agitation did not raise the rate above the normal limits, although it may have kept it from being as low as in the simple depressions.

In the manic-depressive table there has been set out in separate columns a rough estimate of the psychomotor and emotional factors in the clinical picture as shown from day to day. Study of these in relation to the rate indicates that further observations are necessary to determine whether any very close relation exists between these factors and the basal rate, and that one cannot be considered without the other. In addition to the question of cooperating, it should also be borne in mind that a hypomanic state may represent a transient or rather convalescent phase of the psychosis, and for this reason may not be comparable to the more marked manic or depressed states. Gains in weight have been noted in some such cases.

If, as is indicated by these findings, the rate is slightly decreased in depressions, it should probably not be concluded that the basal rate is influenced in the same way in individuals suffering from emotional disturbances but who have not become psychotic. Many of these manic-depressive attacks seem to be clearly precipitated by emotional and other influences similar to those found in the history of many cases of exophthalmic goiter, while in others it is apparently impossible to establish a relation between an emotional disturbing cause and the mental break-down.

DEMENTIA PRAECOX GROUP

Cases which were considered to be essentially and fundamentally of the schizophrenic type have been included in Table 2. As previously

indicated, there was not enough evidence of disturbed endocrine function to explain these definitely abnormal rates in terms of recognized clinical types, i. e., as hypothyroid or hyperthyroid or pituitary. Skin evidence of myxedema was not found in any case in this group. There was no adiposity nor definite infantilism. Evidence of growth disturbance was, however, present in some. One patient (Case 16) gave a history of recent very rapid growth. Another (Case 17) had not attained physical sex maturity and had had a single scanty menstruation. One (Case 18) would probably be classed as polyglandular. None of the males was very definitely deficient in gross gonadal development, and in most of them, including Case 16, it was equal to the adult average. Several patients showed deficient or perverse secondary sex features. In the light of present evidence these lesser degrees of disturbed development of bone, muscle, and the physical characteristics of sex probably cannot be expressed in terms of any one gland. Adequate function of several glands seems to be necessary for complete physical maturity. Therefore, the most that can be said as to their relation to metabolism is that some of the cases show this much evidence of a disturbance of an "endocrine" nature. Some evidence as to the frequency of imperfect and retarded sex development in cases with early onset will be presented by one of us (Gibbs) in another paper.

Starvation or undernutrition does not seem to explain the findings except possibly to some extent in Cases 16 and 19. These patients were poorly nourished and there was some question of restriction of food intake due to an inclination to refuse food. The extent of this could not be determined. None of the others was definitely undernourished. One patient (Case 17) had required to be spoon-fed when admitted in 1920 but for several months had eaten ravenously her own food and that of other patients and was well nourished.

One boy (Case 16) presented several features which suggested a more profound disturbance of metabolism than simple inanition as the cause of the low readings, which averaged —27 per cent. In October, 1920, soon after the patient was 16 years of age, this boy had left his position and found work elsewhere because he thought the girls in the office where he worked were laughing at him. Later he felt too weak to work, and finally in August, 1921, he quit work entirely, and definite ideas of reference were noted. Fear was said by his mother to be a dominating symptom for a year before his admission. After September, 1921, he would not leave the house and was very fearful. In October, 1921, he began to grow so rapidly as to require new clothing. This was associated with a voracious appetite, especially for sweets. About Christmas, 1921, severe headaches developed, appetite became poor and bowels constipated. This continued until February when an acute delusional episode with an attempt at suicide caused admission to the hospital, Feb. 4, 1922.

He was thin, and the muscular wasting, or lack of development, seemed slightly out of proportion to the loss of subcutaneous fat. The thyroid was palpable at the isthmus, but was thought to be small. There was no appearance of myxedema. The testes were of the average adult size with a fair growth

of pubic hair of masculine type. No hair on chest or face. Had to be spoon-fed. Said he could not eat because bowels were stopped up and stomach was full. Bowels moved daily voluntarily or by enema. This was the status when the basal rate determinations were made. There was no loss of weight during the five days between the first and last determinations. February 21 a twenty-four hour urine of 1,250 c.c. contained 3 gm. creatinin and 387 mg. creatin (Folin method, creatinin-zinc chlorid standard). March 2 a twenty-four hour urine of 1,015 c.c. contained 1.349 gm. creatinin and 172 mg. creatin with a total nitrogen of 7.32 gm. (Kjeldahl). February 17 the fasting blood sugar was 112.4 mg. per 100 c.c. (Folin), and forty-five minutes after the ingestion of 80 gm. of glucose it had risen to 230 mg. Sugar did not appear in the urine (Benedict).

Further observations could not be made because the patient became so actively suicidal in response to his delusions as to require constant restraint in a protection sheet. Thyroid, 2 grains daily, was given from March 9 to March 19, but produced no appreciable effect and was discontinued because of a loss in weight. Restraint continued to be necessary. April 15 the hands and forearms were markedly cyanotic and cold, and passive motion at the elbows was difficult because of greatly increased muscle tonus. Tube fed twice daily. Anterior pituitary (Armour), $\frac{1}{4}$ grain daily, with one of the meals was begun, since which time gradual increase in food intake with gain in weight has been noted. May 5 he was taking his food voluntarily; muscular tension has relaxed and cyanosis almost gone.

The cases are too few to attempt correlations between the rate and the clinical picture as a whole or separate symptoms or factors. Just how much the rate varies with the clinical picture, with the quiet and disturbed phases, the fluctuations in weight, appetite, and behavior which some of these patients show must be the subject of further careful observations, following the same patient through these changes. In the cases studied those which seemed to be in the more active or acute phases of the reaction also showed the greatest variation from the normal rate. In Case 19, however, it was noted that with an increase in the severity of symptoms, the rate became more nearly normal. Two factors may have influenced it, the greatly increased muscle tonus or the increased protein in the tube-fed meals of milk and eggs which the patient had been receiving for three days before the last reading.

Correlation between the basal rate and the psychomotor and emotional factors has not been attempted in this group, since they are in many cases so much more difficult of description, evaluation, and classification than in the affective group. In certain of the dementia praecox cases with a definite emotional coloring the basal rate showed quite definite variations from normal. In Case 16 there was marked depression and apprehension on a delusional basis, while in Case 26 there were periods of excitement and over-activity and an increased rate just following and preceding such periods. In other cases however (Cases 17 and 18), the emotional factor was not prominent, and there were also definitely low readings.

MISCELLANEOUS AND CONTROL GROUP

Case 27 was not included in the dementia praecox group because some doubt remains as to the essential nature of the psychosis. The patient recovered from the first episode with apparently complete insight. The diagnoses made at the time are indicated in Table 3. The clinical picture at the time the readings were made was one of depression. The readings were lower than in the simple depressions and the rate was not raised by thyroid, suggesting the possible presence of some constitutional factor not present in the simple depressions.

There is also some question as to the diagnosis of cases classed as psychoneurosis. They have been introduced as control cases for the reason that they were in a settled chronic state rather than an acute phase of their psychosis. Cases of psychoneurosis which would afford a satisfactory basis for comparison with neurotic types usually regarded as nonpsychotic were not available in the hospital at the time these observations were made.

Three nurses and one physician who served as controls gave normal readings, while one nurse and one physician gave abnormal readings, the evidence for which is shown in the tables.

The discussion in this paper has probably gone into more detail than is warranted by the data. It may be justified by bringing out some of the points to be considered, especially that in functional studies of this character interpretation of the findings must be made in the light of the clinical state or phase presented by the patient at the time. Some of the reports on biochemical studies in the functional psychoses indicate that this has not always been considered. The work of Folin⁵ on metabolism in mental disorders has been subjected to this criticism by Pighini and Statuti.⁶ It is of interest to note that while the work of Folin was quite exhaustive on the chemical side, the selection of cases and limited clinical observations prevented correlations between the chemical findings and the acute and chronic phases. The seven dementia praecox cases studied were all in the chronic phase. If there are abnormal variations in the metabolism in dementia praecox it would seem probable that such changes would be most marked and therefore most tangible and appropriate for study in the more active and acute phases of the process. Pighini and Statuti found an excessive elimination of nitrogen, phosphorus, and unoxidated sulphur in all of six cases of dementia praecox in an acute exacerbation. Benedict⁷ recently suggested a close relation between nitrogen loss and decreased basal rate.

5. Folin: *Am. J. Insanity* **60**:699, 1904; **61**:299, 1904.

6. Pighini and Statuti: *Metabolism in Dementia Praecox*, *Am. J. Insanity* **67**:299, 1910.

7. Benedict: *Metabolism During Starvation and Undernutrition*, *New York M. J.* **115**:249 (March) 1922.

TABLE 3.—MISCELLANEOUS AND CONTROL GROUP

	Date, 1922	Basal Rate, per Cent.	Cooperation	T.	P.	R.	Weight, Lbs.	Height, M.	Surface Area Ht.-Wt. Formula (DuBois)	Volume Expired Liters per Hour	Gas Analysis		Calo- ries per Hour	R. Q.
											CO ₂ Cent.	O ₂ Cent.		
No. 27. Male 18; Adm. 8/18/21; D. P. (case not clear); parotid 11/23/21; psychosis with psychopathic personality; paranoid hallucinatory episode; recovered. Returned to hospital 2/18/22; depressive; rapid growth 6 months prior to first admission; antisocial behavior beginning at 13 years; fear seems to be a prominent factor; quiet; inactive	2/24	-14	Satisfactory	98	60	20	109	1.57	1.47m ²	378.8	2.85 2.85	18.04 18.07	54.13	0.781
	2/27*	-19	Satisfactory	98	60	20	109.5	....	....	373.2	2.97 2.95	18.17 18.22	50.97	0.831
	3/22	-17	Satisfactory	98	52	21	104	....	1.44	402.8	2.25 2.26	18.39 18.36	51.29	0.859
No. 28. Male 13; Adm. 2/2/22; postencephalitis psychosis; overactive, talkative; adipose; some hypopituitary features, but gonadal development precocious, with feminine pubic hair	3/3	-20	Satisfactory	98	69	24	142	1.67	1.71	443.9	2.76 2.79	17.83 17.86	64.44	0.805
	3/13	-16	Satisfactory	99 ²	76	22	142	....	....	450.5	2.75 2.72	17.73 17.76	71.80	0.825
No. 29. Female 28; Adm. 12/19/19; psychoneurosis, anxiety type; masculine hair growth; history of pelvic operation	3/24	+ 7	Fairly satisfactory; restless before, quiet during test	98.8	96	14	95	1.48	1.32	291.1	2.91 2.93	17.31 17.31	52.44	0.766
	3/27	- 4	Satisfactory	98.6	84	13	95	....	....	277.0	2.71 2.69	17.53 17.56	46.63	0.756
No. 30. Psychoneurosis, neuroathenic type; female 42; adm. 12/31/21; previous admission, one	3/24	± 0	Satisfactory; breathing irregular	97.8	96	25	72.5	1.54	1.225	372.4	1.94 1.96	18.54 18.57	44.04	0.783
No. 31. Psychoneurosis, psychasthenic type; female 41; Adm. 1/20/15; masculine hair growth	3/27	- 4	Satisfactory	98.6	82	19	101.5	1.56	1.47	350.1	2.33 2.33	18.02 18.04	50.57	0.761
	3/28	- 8	Satisfactory	98.2	66	22	...	....	....	356.8	2.28 2.31	18.21 18.21	48.44	0.809
Dr. H., age 27.....	3/20	+ 5	Satisfactory	98.4	80	11	125	1.63	1.60	397.2	2.87 2.90	17.59 17.59	66.31	0.833
Miss F., nurse, age 18.....	3/17	+ 4	Satisfactory	98.4	80	24	132	1.55	1.57	393.9	2.79 2.79	17.60 17.62	65.26	0.804
Miss M., nurse, age 22.....	3/17	+ 2	Satisfactory	98	72	20	138.2	1.56	1.61	344.5	2.89 2.88	17.42 17.40	60.51	0.781
Miss H., nurse, age 23.....	3/10	+ 5	Satisfactory	98.2	76	24	128.8	1.60	1.60	386.5	2.63 2.62	17.72 17.72	61.82	0.780
Miss L., nurse, age 23; several attacks tonsillitis; 20 lbs. underweight; fine tremor fingers; thyroid doughy, possibly slightly enlarged	3/10	+25	Satisfactory	98.2	64	16	126.3	1.61	1.59	317.2	3.81 3.83	16.29 16.33	73.04	0.789
Dr. B., age 33; adipose.....	3/22	-16	Satisfactory	98	60	11	131.5	1.74	1.96	363.4	3.07 3.04	17.26 17.33	65.09	0.816

* Thyroid, 2 gr. daily, 3/10 to 3/21.

SUMMARY

1. Definitely abnormal basal rates were found in psychotic patients in the more acute phases of their psychosis. The variations from normal were greater in dementia praecox patients than in manic-depressive insanity.

2. The patients did not show sufficient evidence to explain satisfactorily the findings in terms of thyroid or pituitary disorder. Several of the dementia praecox patients did show some evidence of disturbed growth, including incomplete sex maturity.

3. Thyroid by mouth raised the rate to normal in two cases of manic-depressive depression, but did not in a case with more marked constitutional psychopathic features. No immediate mental improvement followed thyroid in these three cases.

4. Inanition was not thought to account for the low readings except possibly to some extent in two cases. In one of these there was found a creatinin excretion of 33 mg. per kilo, with 172 mg. creatin, in twenty-four hours, and in the other a creatinin excretion of 26.8 mg. per kilo, with 195 mg. creatin, in twenty-four hours.

5. In functional studies in the psychoses the findings should be considered in relation to the symptoms and phases or stages presented by each patient as well as to the clinical group to which he belongs.