BASAL METABOLISM IN LEPROSY[1]

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Leprosy has been handed to us from ancient times as one of the most puzzling diseases known to science. Present-day knowledge concerning some of the most important features of this malady is still unsatisfactory. Despite the large amount of work that is being carried out in trying to solve the problems that it presents, very little has been done to determine the physiological and metabolic factors at work. All problems, therefore, the solution of which will tend to increase knowledge of these factors, physical or chemical, are of importance.

Metabolism is the cellular activity that is coincident with life and consists of the regeneration and degeneration of the cells of the body. In the process of building up and breaking down, oxygen is taken up by the tissues and carbon dioxide is eliminated. Heat comes from oxidation in the active protoplasmic tissue of the body, and heat dissipation is regulated according to its production. Any rapid change in the relative amount of protoplasmic tissue will cause changes in the basal metabolic rate (4). Since basal metabolism is the measurement of the rate of vital activities under standard conditions of emotional and physical repose, and since leprosy produces pathological changes in many tissues of the body, it seemed of interest to know whether or not there would be a change in cellular activity, thereby changing the heat production of the body. The basal metabolic rate has been of value in the study of various diseases, particularly those associated with the endocrine glands and in certain nonendocrine diseases, such as severe forms of secondary anemia and cardiorenal diseases.

For this study three hundred and eighteen cases of leprosy were selected, representing the various nationalities, types, durations of leprosy and stages of progression of the disease. Two hundred and seven were males and one hundred and eleven were females.

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For comparison, check tests were made on thirty presumably normal individuals, members of the staff and personnel.

All of the patients studied were ambulatory, with body temperatures within the normal limits. Patients having a rise in temperature were not considered because, according to DuBois (3), fever increases the metabolism 7 percent for each degree Fahrenheit. Patients with massive infection of the nasal cavities and extensive ulceration of the mucous membrane of the mouth were ruled out because of the discomfort of the mouth piece and nose clip, which might lead to error. Since dyspnoea increases muscular activity and raises heat production, patients with laryngeal infiltration were not chosen. In two hundred and fifty of the cases erythrocyte counts, leucocyte counts and hemoglobin estimations were made.

PROCEDURE

All tests were carried out on patients in the postabsorptive state (i.e., after an approximate fourteen hour fast), between the hours of 7 a.m. and 8 a.m. and after at least thirty minutes of observed rest. The temperature of the room was regulated so that the patient was in a comfortable environment. In order to allay apprehension and insure physiological repose, the patients were instructed in the details of the test and shown the apparatus on the previous day. A Benedict-Roth apparatus was used. The efficiency of the soda-lime was tested frequently, and during each test the apparatus was examined for leaks. Check tests were made in all instances and the second reading was used unless there was a discrepancy sufficient to invalidate the findings.

In metabolism testing two sets of normal values are commonly referred to, the Benedict and the DuBois normals. In an extensive study of basal metabolic rate determinations Boothby and Sandiford (1) of the Mayo Clinic showed that 92.1 percent of normal individuals have a basal metabolic rate within ± 10 percent and 99.3 percent within ± 15 percent of the DuBois standards. Our results were computed according to the chart furnished with the Benedict-Roth recording metabolism apparatus, and are the DuBois normal standards as modified by Boothby and Sandiford. Morse (7) states in substance that normal variations in the basal metabolic rate may vary about 15 percent on either side of the normal standard ± 10 percent without indicating a pathological state. The determinations of

the controls ranged between —12 percent and +15 percent, with an average rate of +5 percent.

Findings.—The results recorded in Table 1 show that two hundred and forty cases (75.4 percent) had a basal metabolic rate within the normal range (—15 to +15 percent), while

TABLE 1.—*The basal metabolic rate in 318 cases, in total and according to sex, age and in relation to circulatory findings.*

	Percentage rate						
	Below—20	—20to—15	—15to—10	—10to+10	+10to+15	+15to+20	Over +20
TOTAL cases.....	13	6	20	189	31	21	38
Distribution according to sex							
Male.....	9	6	10	101	25	10	30
Female	4	0	10	62	6	11	4
Male, colored	0	0	0	14	0	0	4
Female, colored.....	0	0	0	12	0	0	0
Distribution according to age							
10-20 years.....	0	0	0	20	4	0	5
20-30 years.....	2	1	6	65	16	4	8
30-40 years.....	7	2	4	65	7	10	12
40-50 years.....	0	0	9	24	1	2	3
50-60 years.....	4	3	1	10	0	3	10
60-70 years.....	0	0	0	5	3	2	0
Relation to circulatory findings							
Pulse rate, lowest.....	54	54	54	57	66	66	66
Pulse rate, highest....	98	94	110	120	130	132	138
Hemoglobin, lowest[a]...	77	82	75	70	76	33	66
Erythrocytes[b].....	3.2	4.5	3.5	3.0	3.2	2.6	3.2

[a] Percent. [b] Millions per cmm.

seventy-eight cases (24.6 percent) showed abnormal rates. Of the latter, the rates for twenty-one cases (6.6 percent) were between +15 and +20 percent; thirty-eight cases (11.8 percent) were above +20 percent, and nineteen cases (6 percent) were below —15 percent. The lowest rate was —28 percent and the highest rate was +66 percent. The results of those obtained above +20 percent may be grouped as follows:

Rates	*Cases*
+20 to +30 percent	18
+30 to +40 percent	12
+40 to +50 percent	6
+60 to +70 percent	2

Of the fifty-nine cases having basal metabolic rates above +15 percent, ten were arrested cases; three cases were extremely nervous and had rates of +39, +22 and +16 percent respectively; one had exophthalmia and a rate of +30 percent; one had a rate of +66 percent and, with supervised rest of two weeks, the rate dropped to +27 percent; the cause of this rate was undetermined. One case with secondary anemia had a rate of +15 percent; one had asthma and a rate of +39 percent; and one had an enlarged spleen with a rate of +40 percent. Neurotic disturbances may have been a factor in eight of the cases which had spirometric tracings which were irregular and of the sighing type. Cates (2) states in substance that emotional stability may at times be revealed by the spirometric tracing used in the determination of the basal metabolic rate by indirect calorimetry. The spirometer records the speed, depth, and regularity of the respiratory movements. It has been observed that irregular or sighing types of respiration are frequently found in patients with some manifestations of the psychoneuroses. A bizarre pattern suggests the possibility of an environmental or psychogenic component in the patient's reaction. In the remaining thirty-three cases, eleven had leucocytosis with no evidence of glandular disturbance.

Of the nineteen cases having a basal metabolic rate below —15 percent, four were arrested cases; two cases with a rate of —22 percent had nephritis with edema; one with a rate of —20 percent had diabetes, and one with a rate of —24 percent had hypothyroidism. In the remaining eleven cases there was no evidence of glandular disturbance.

Of the two hundred and fifty cases in which blood counts were made, thirty-eight had leucocytosis, the counts ranging between 10,000 and 23,000 per cmm.; these are grouped as follows:

Rates	*Cases*
Cases with normal rates	18
Cases with rates over +15	11
Cases with rates below —15	9

The pulse rate in the entire series ranged between 54 and 138 and, except in rare instances, corresponded with the basal metabolic rate. The pulse record was obtained during the metabolism test, when complete relaxation was emphasized.

Relation to the stage of leprosy.—The results recorded in Table 2 show that there is no definite correlation between the basal metabolic rate and the various types of the disease and stages of its

progression. Of the three hundred and eighteen cases, forty-four were arrested cases.

TABLE 2. *Basal metabolism rates according to stage of progression of the disease.*

	Percentage rate						
	Below −20	−20 to −15	−15 to −10	−10 to +10	+10 to +15	+15 to +20	Over +20
Arrested	2	2	5	22	3	0	10
C1N1	0	0	1	21	3	0	2
C1N2	0	0	0	7	0	3	0
C1N3	4	0	0	4	6	0	1
C2N1	1	1	0	28	0	4	2
C2N2	0	0	0	14	0	1	0
C2N3	2	0	0	0	3	0	0
C3N1	2	0	2	22	8	0	8
C3N2	2	0	5	38	4	10	5
C3N3	0	0	0	4	0	0	2
C1	0	0	1	5	0	0	2
C2	0	0	0	0	0	2	0
C3	0	1	4	17	2	0	3
N1	0	0	0	1	0	0	0
N2	0	1	2	5	2	1	0
N3	0	1	0	1	0	0	3

DISCUSSION

In the entire series of cases studied the amount of tissue destruction or retrogression of the disease had no apparent influence on the basal metabolic rate. Since the completion of this work, which was begun in the early part of 1931 and completed in February, 1939, Moraes Jr. (6) has reported results of similar determinations in one hundred cases of leprosy in Brazil. His conclusions were as follows:

1. The basal metabolism is always increased in leprosy, even when there are no known facts determining that increase.
2. Lepra reaction seems to influence generally metabolic changes, increasing basal rate.
3. In quiescent cases of leprosy, the basal metabolism has tendency to return to limits of normality.

In our series, two hundred and forty cases (75.4 percent) had rates within the normal range (—15 to +15 percent). Of the remaining seventy-eight cases, fourteen had pathology that would increase or decrease the basal metabolic rate independently of leprosy, and an additional fourteen cases were bacteriologically negative. In forty-four of the cases the causes of the abnormal rates were undetermined; it is not clear whether these results are referable directly to leprosy or to some unknown intercurrent condi-

tion. Just why there should be a difference in the two studies is not known. If Moraes based his normals on +10 percent, compared with his findings our group of one hundred and eighty-nine cases (59.4 percent) fell within this range. The difference noted may be a racial factor, though our group consisted of several nationalities and showed no marked variations as to race. Climatic conditions and dietary factors may perhaps be involved. McConnell et al (5), in a study of the basal metabolism as affected by atmospheric conditions, state that the rate increases rapidly when the temperature of the environment is higher than that of the body. Moraes' study was made in a tropical climate, and this may have influenced the findings.

At the Carville leprosarium importance is placed upon the general welfare of the patients as a prerequisite to, and in combination with, specific medication. The food is of good quality and is well served. Recreations available to the entire community are golf, baseball, volley ball and tennis. In the evenings there are moving pictures three times a week. Each patient is maintained in as good general health as possible. The application of prophylaxis and elimination of many foci of infection have assisted in the ultimate improvement of the systemic condition in our patients.

SUMMARY AND CONCLUSIONS

The basal metabolic rate was determined on three hundred and eighteen lepers, representing the various types and stages of progression of the disease and various nationalities. Not included were cases with fever, leprous infiltration of the larynx, or massive infection of the mucous membrane of the mouth and nasal cavities.

The erythrocyte count, leucocyte count and hemoglobin estimation was made on two hundred and fifty of the cases.

As controls, the basal metabolic rates of thirty apparently normal individuals living under the same climatic conditions were determined.

Of the three hundred and eighteen cases, two hundred and forty, or 75.4 percent, had rates within the normal limits. There was no definite correlation between the rates and the various stages of progression of the disease.

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