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New Formulae for Prediction of Basal Metabolism from Pulse Rate and Pulse Pressure.

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In a previous study[1] one of us derived a multiple prediction formula for estimating basal metabolic rate from pulse rate and pulse pressure. Recent interest in the clinical usefulness of this formula made it advisable to reinvestigate this problem and attempt to increase its reliability if it is to be applied clinically. Pulse rate and pulse pressure changes which were found to parallel variations in basal metabolic rate were interpreted as indicative of accompanying alterations in blood flow. The subsequent development of methods for measuring blood flow, and their applications in myxedema and thyrotoxicosis, have demonstrated that heat production, and minute volume closely parallel each other. Simultaneous determinations of blood pressure show that minute volume can be roughly estimated clinically by determining the pulse rate and blood pressure. We first assumed that minute volume varied directly with the product of the pulse rate and the pulse pressure. However, resting minute volume must also vary with the individual's size, so this factor was introduced by multiplying the pulse rate-pulse pressure product by surface area. Combining the above equations, we obtain:

Total heat production = K · Pulse Pressure · Pulse Rate · Surface Area.

Dividing both sides of the equation by surface area gives:

Calories per sq. m. per hour = K · Pulse Rate Pulse Pressure.

The next step was to ascertain whether or not observations on patients would fit this equation. When the data were assembled, it became evident that the products of pulse rate and pulse pressure were in general higher, and the heat production lower, in women than in men. The derivation of separate formulae for the 2 sexes was therefore essential. Observations were recorded on 416 women and 321 men. A correlation table was prepared for each sex and the equations for the regression lines were determined in the usual way. The simplified final equations are:

[1] Read, J. Marion, *Arch. Int. Med.*, 1924, **34**, 553.

Men

$$\text{Cal. per sq. m. per hr.} = \frac{\text{P.R.} \times \text{P.P.}}{200} + 27$$

Women

$$\text{Cal. per sq. m. per hr.} = \frac{3 \times \text{P.R.} \times \text{P.P.}}{700} + 24$$

The correlation coefficients were slightly over 0.8 in each case.

Since the basal metabolic rate is expressed as a percentage above or below fixed normal standards for age and sex, it is evident that any attempt to derive a formula giving the B.M.R. directly must increase the scatter of the observations. We therefore determine only heat output from which the B.M.R. must be calculated in the usual way. This new procedure, together with the separation of the sexes and introduction into the formula of the individual's size have all operated to increase the accuracy of our prediction formulae.

To ascertain their prediction value the formulae were applied to 100 consecutive new cases, omitting from the series all cases with arrythmias, hypertension or other cardiovascular disease which produced alterations in the pulse rate and pulse pressure obviously not caused by changes in blood flow. These were the same criteria used in compiling the data from which the formulae were derived. There were 21 males and 79 females in this new series to which the formulae were applied with the following results:

ERROR NOT MORE THAN				
5%	10%	15%	20%	25%
59	78	94	98	100

Of the 22 cases in which the disagreement between the measured and predicted rate exceeded 10%, nine of the paired values both fell within the accepted normal range of —10% to +10%. Of the remaining 13, two gave normal and 11 abnormal rates by indirect calorimetry. Of these 11 the direction of metabolic change was the same in both pairs in 10, and in the 11th the values were +1% and —12%.

In judging the value of any formula for estimating the basal metabolic rate it should be recognized that the standard to which we compare the estimated rate is not determined with perfect accuracy. The variable error inherent in the complexity of indirect calorimetry has been discussed by Jenkins[2] and others. In fact we have made additional use of the pulse rate-pulse pressure prediction formula to detect gross errors in metabolic rate determinations by indirect calorimetry. The pulse rate alone has proven very useful for many years for this same purpose.

[2] Jenkins, R. L., *Arch. Int. Med.*, 1932, **49**, 181.

It is probable that the accuracy and clinical value of our formulae may be enhanced by altering its constants, which may be advisable after recalculation upon a larger series.

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Bacteriology of Leprosy. II. Growth and Staining Reactions of Organisms Inoculated into Minced Chick Embryo Medium.

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In a previous communication[1] a description was given of an acid-fast organism isolated from human and rat leprous lesions by the tissue culture technic.

Some of the organisms were acid-fast and some non-acid-fast in fresh tissue cultures and in minced embryo medium, but entirely acid-sensitive on the usual laboratory media.

The best growth of acid-fast organisms occurred in from 24-48 hours. There were usually as many acid-fast as acid-sensitive organisms present. After this period of incubation the acid-fast rods gradually disappeared and on about the tenth day the organisms were non-acid-fast or almost so. On transferring to fresh tissue cultures or minced embryo medium, the above picture was repeated.

The tinctorial characteristics varied depending upon the living condition of the tissues. In vigorous, actively growing tissues the organisms were strongly acid-fast. As the tissues became less vigorous the acid-fast property was less pronounced and, finally as the tissues died and autolyzed, only non-acid-fast diphtheroids were seen.

The organisms isolated from human and rat lesions revealed the same morphological and physiological characteristics. It was, therefore, concluded that human and rat leprosy are caused by the same organism.

In order to determine whether or not the acid-fast phase is characteristic of bacteria in general, when inoculated into minced embryo medium, the following organisms were tested: *Escherichia coli, Eberthella typhi, Eberthella dysenteriae, Eberthella paradysen-*

[1] Salle, A. J., *J. Infect. Dis.*, in press.