

tent was extremely low compared to that used in other experiments. The phosphorus was .177% instead of .254%. The ratio of Ca/P, which in former experiments was 4.25, in this experiment was 6.0.

The metabolism data demonstrate that the cure of rickets is not necessarily associated with great increase in the phosphorus balance. On this severe diet, negative balances of phosphorus would probably result without the curative agent. In the rickets controls, the calcium is retained in excess of the phosphorus; in the cured animals even larger amounts of calcium were retained. This indicates that healing of the condition causing deficient bone deposition may be effected by much efficient utilization of the phosphorus as well as by increase in the retention.

Summary: Marked cure of rickets in rats is secured in 2 weeks, by cod liver oil and by .01 mg. daily of irradiated ergosterol. This is shown by histological preparations of the bones, the analyses of the blood serum for calcium and phosphorus and the ash analyses of the bone. The metabolism studies demonstrate that the cure is accomplished without great increase in the retention of calcium or phosphorus.

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Prediction of the Basal Metabolism of Infants from the Measured Insensible Perspiration.

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Measurement of the respiratory exchange of infants by present methods is time-consuming and technically difficult. The result is that only 3 or 4 pediatric clinics in America are making any attempt at present to study the subject. This paucity of data is regrettable since a knowledge of the energy metabolism furnishes the scientific basis for the feeding of infants in health and in nutritional disturbances, besides yielding valuable information in many other conditions. For these reasons, the attempt has been made to extend to infants the method proposed by Benedict and Root¹ for predicting the probable metabolism of adults from the insensible perspiration as measured with the aid of a delicate balance. The results thus far obtained with the method are presented in this preliminary report.

¹ Benedict, F. G., and Root, H. F., *Arch. Int. Med.*, 1926, xxxviii, 1.

The method is based on the close relationship which exists in the human organism from early infancy to old age between the production of heat and the loss of heat by way of vaporization of water through the skin and lungs. Du Bois² has shown that under standard conditions of clothing, temperature and humidity, healthy adults at rest and in the post-absorptive state lose approximately 25% of their heat in vaporization through the above channels. This relation was maintained in all of the afebrile diseases investigated.

Simultaneous measurements of heat production and water elimination in the respiration chamber at the New York Nursery and Child's Hospital demonstrated that under comparable conditions normal and marasmic infants lose the same proportion of heat in vaporization as adults; namely, 26%, the extreme values being 23 and 30%.³ The chart shows this relation between heat production, expressed as calories per 24 hours, and insensible perspiration, expressed as gm. per hour. The term insensible perspiration, as commonly used and as recorded in the chart, includes other gaseous emanations than water vapor, the chief component being carbon dioxide. Atmospheric oxygen is absorbed at the same time as carbon dioxide is exhaled. The difference or the weight of the carbon

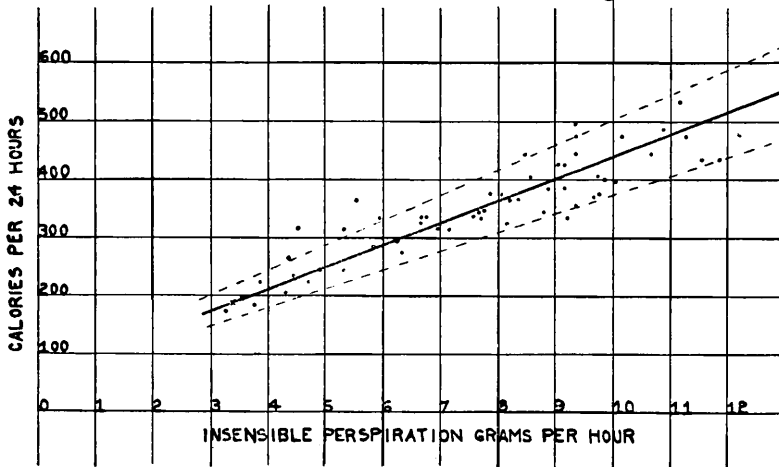


CHART 1.

Relationship in infants between the insensible perspiration per hour and the heat production per 24 hours as simultaneously measured in the respiration chamber. Dots indicate normal infants; circles, marasmic infants, and the cross, a cretin. The straight line curve represents the general trend of the points. The area between the dash lines indicates a deviation of 15% from the straight line curve.

² Soderstrom, G. F., and DuBois, E. F., *Arch. Int. Med.*, 1917, xix, 931.

³ Levine, S. Z., and Wilson, J. R., *Am. J. Dis. Child.*, 1928, xxxv, 54.

together with the water vapor constitutes the total loss of weight or insensible perspiration. The fraction ascribable to carbon is between 10 and 15%, depending on the respiratory quotient.

Although observations are as yet too few to justify mathematical treatment a straight line curve correlating heat production with insensible perspiration has been tentatively drawn, according to the method proposed by Benedict and Root for adults. The scatter of individual points, each of which represents a single observation in the respiration chamber is relatively slight and does not exceed the scatter found on most standard charts of basal metabolism. In all, 58 observations were made on 18 infants. Only 9 of the 58 points deviate from the arbitrary curve, as laid out, by more than 15%. Only 3 of the points exceed a deviation of 20%. When one considers the many errors inherent in the measurement of water output in the respiration chamber, one may reasonably conclude that the discrepancies noted above may be ascribable as much to errors in technic as to intrinsic variations in the water output of individual infants.

The existence in infants of a condition of equilibrium between heat production and insensible perspiration induced us to make an attempt to predict their metabolism from their insensible perspiration measured outside of the respiration chamber. The technic of measurements consisted briefly of weighing infants on a delicate balance having a capacity of 10 kg. with an accuracy of 20 mg. under standard conditions of clothing, temperature and humidity. Observations included one or more half- to one hourly periods and were invariably made during sleep, in the absence of visible perspiration and at least 1 hour after the ingestion of a small meal. The frame and rubber mattress on which the subjects lay were specially constructed to permit the collection of urine and feces without loss. A complete description of the apparatus, details of the method, sources of error and precautions taken to avoid these errors will appear in a later communication.

To date, 9 normal infants, 6 marasmic infants and 1 cretin have been studied in 23 basal observations by the method of weighings. The heat production of 8 of the infants was also measured in the respiration chamber either on the same day or within a day or 2 of the weighings under the same basal conditions. The basal heat production of the remaining infants was estimated from the standard tables of Benedict and Talbot⁴ in the case of normal infants, and

⁴ Benedict, F. G., *Boston M. and S. J.*, 1919, clxxx, 107; Benedict, F. G., and Talbot, F. B., "Metabolism and Growth from Birth to Puberty," *Carnegie Inst. Wash.*, Pub. 302, 1921.

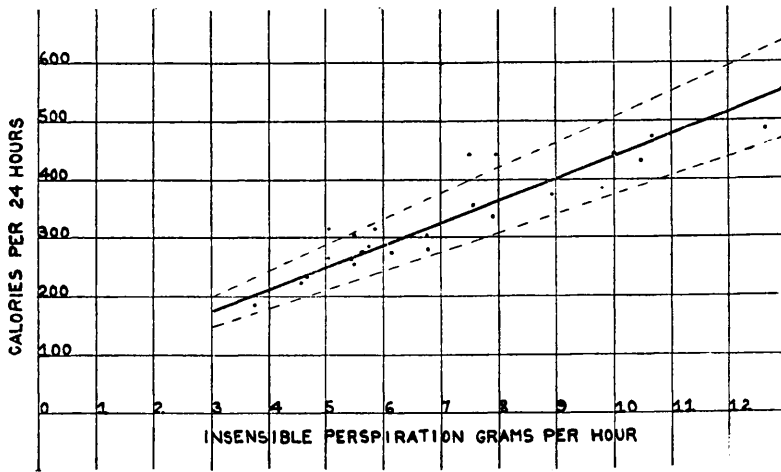


CHART 2.

Shows the same relationship as Chart 1. Insensible perspiration measured by the method of weighings, and the heat production determined in the respiration chamber or estimated from standard tables. The straight line curve shown in Chart 1 also represents the general trend of these points and is suggested as a method for predicting the metabolism of infants from the measured insensible perspiration.

from the average figures previously compiled by us⁵ in the case of marasmic infants. Chart 2, arranged similarly to Chart 1, graphically shows the results. Each point on the chart represents the insensible perspiration as obtained by the method of weighings together with either the actually determined or estimated basal metabolism.

A straight line curve drawn through the scatter of points duplicates precisely the arbitrary curve constructed in Chart 1 from the results obtained in the respiration chamber experiments. Only 3 of the 23 points representing individual observations deviate from the curve by more than 15%. It seems probable, therefore, that the values for insensible perspiration obtained by the simple method of weighings may serve as an index for predicting the metabolism of infants. In view, however, of the relatively few observations thus far made on infants with this method and because of the significant deviations which have occasionally been found, the particular straight line curve suggested for predicting the metabolism of infants from the measured insensible perspiration must await confirmation before adopting it finally for purposes of prediction. With further refinement in the method and with added investigation it is possible that the slope of the curve may require slight change or

⁵ Levine, S. Z., Wilson, J. R., and Gottschall, G., *Am. J. Dis. Child.* In press.

that deviations may be even further reduced. Studies are now in progress to test the reliability of the method and to determine the effect of various factors, such as food, visible perspiration, activity, body and environmental temperature and humidity on the insensible perspiration of infants.

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Rate of Development of Pneumococcus Immunity.

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Inasmuch as pneumonia is a self-limited disease ending by crisis or lysis generally between the 7th and 10th days, 3 to 5 days are frequently afforded in which an attempt may be made to produce active immunity before the natural termination of the disease takes place. At the suggestion of Dr. A. R. Dochez a study was therefore undertaken of the onset and rate of development of pneumococcus immunity.

The development of pneumococcus immunity after the introduction of pneumococcus vaccine has been studied from many points of view. The onset of immunity has been noted from the 5th to the 14th day by different workers,¹ in a few observations as early as the 3rd day. Many preparations of the antigens have been employed. Some workers² have believed the intact cell necessary for the production of well-marked type-specific immunity, whereas others have found that extracts or solutions of the cells were equally effective.³ As we were interested in the preparation of a vaccine that would be especially effective in initiating early immunity, we compared in this regard a vaccine made from the intact cell with that obtained from a watery extract of the cell.

Three antigens were employed (1) a vaccine made from the intact cell, (2) a Berkefeldt filtrate of shaken bacteria, (3) a Berkefeldt filtrate of the broth culture. The method of preparation was as follows:

A pneumococcus type 11 organism of high virulence was grown for 6 hours in 2.5% human serum beef-infusion broth. This was used to inoculate 250 cc. flasks of similarly prepared broth in the

* With the technical assistance of Mr. Max Soroka.