at the same time. The mortality began early in the fifth day with 7 birds dying during this time. On the sixth day there were 26 bloody droppings but no mortality, and on the seventh day there were 26 bloody droppings which were the last indications of hemorrhage. All the blood in all the droppings from this group was very fluid and watery. The 3 survivors never were very ill since they gained in weight rapidly after the fifth day.

*Conclusion.* 1. Administration of vitamin K in the dietary of chicks definitely decreased the mortality in chicks parasitized by *E. tenella,* a hemorrhage-producing protozoan, since all autopsies performed show the vitamin K-protected birds had a fibrinated core in the caeca, which was in the process of being reabsorbed. 2. Vitamin K-protected birds showed a mortality of only 10% in comparison to 70% mortality in the unprotected group.

## 13297

## Influence of Body Size on Gaseous Nitrogen Elimination During High Oxygen Breathing.*

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(Introduced by Walter W. Palmer.)

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By breathing a gas mixture whose nitrogen content is low, as by the inhalation of almost pure oxygen, the nitrogen physically dissolved in body fluids and tissues is gradually excreted in the expired air. A correction for excreted nitrogen is important in the determination of the residual air of the lungs according to certain methods, such as that of Christie[1] or the more recent open-circuit method of Darling, Cournand, and Richards.[2]

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1 Almquist, H. S., and Stokstad, E. R., *Nature,* 1935, **136**, 31.

2 Becker, E. R., *Coccidia and Coccidiosis of Domesticated Game and Laboratory Animals and of Man,* 1934.

3 Dam, H., and Schonheyder, T., *Biochem. J.,* 1934, **28**, 1355.

4 Dam, H., *Biochem. J.,* 1935, **29**, 1273.

* Under a grant from the Commonwealth Fund.

1 Christie, R. V., *J. Clin. Invest.,* 1932, **11**, 1099.

2 Darling, R. C., Cournand, A., and Richards, D. W., Jr., *J. Clin. Invest.,* 1940, **19**, 609.

The rate of excretion of nitrogen during short periods of oxygen breathing has been studied by Campbell and Hill,[3] Behnke, Thomson, and Shaw,[4] and Darling, Cournand, Mansfield, and Richards.[5] As reviewed by the latter investigators, the values in the literature are in general agreement, averaging approximately 220 cc of nitrogen excreted during 7 minutes of pure oxygen breathing. An examination of the individuals upon whom nitrogen excretion values were determined, however, reveals that all were adults and of fairly large size. If the open-circuit method is to be applied to smaller individuals and children, a more accurate correction for nitrogen excretion must be obtained, since the correction becomes more important, the smaller the residual air.

The purpose of this study was to determine nitrogen excretion values in subjects of various ages and sizes. From this, it was hoped that a regression curve and formula could be established that would enable one to obtain a correction factor depending on the size of the individual.

*Experimental.* An effort was made to obtain as large a range as possible, in size and age of individuals. Since, however, other authors had made determinations on adults, we emphasized smaller individuals and children. Table I gives the age and physical characteristics of a group of 30 subjects on whom determinations were made. Of these, 23 were under the age of 20, while several were under 10.

TABLE I.

| | Mean | Standard deviation | Range |
|---|---|---|---|
| Age (years) | 17.8 | ± 9.6 | 9 - 44 |
| Weight (kg) | 54.8 | ± 18.0 | 27 - 93 |
| Height (cm) | 161.2 | ± 16.7 | 129 -188 |
| Surface Area (sq.m) | 1.56 | ± 0.34 | 0.98- 2.15 |

All subjects were under basal conditions with at least 6 hours of fasting and a period of rest of 30 minutes. The residual air was first determined by the method of Darling, *et al.*,[2] after which at least 15 minutes were allowed to elapse before the start of the nitrogen excretion determination. The latter was carried out in duplicate, with 15 minutes or more between the first and second runs, using the method of Darling, Cournand, Mansfield, and Richards.[5] The

[3] Campbell, J. A., and Hill, L., *J. Physiol.*, 1931, **71**, 309.

[4] Behnke, A. R., Thomson, R. M., and Shaw, L. A., *Am. J. Physiol.*, 1935, **114**, 137.

[5] Darling, R. C., Cournand, A., Mansfield, J. S., and Richards, D. W., Jr., *J. Clin. Invest.*, 1940, **19**, 591.

essential features of this method are: (a) a series of 4 maximally deep breaths of pure oxygen, by which the nitrogen of the intrapulmonary air is reduced to approximately 4%; followed by (b) a 7-minute period of breathing pure oxygen, the expired air of this period being collected and analyzed for nitrogen. If the residual air volume of the lungs is known, the excess nitrogen excreted from the body during this interval can readily be calculated.

For the analysis of the high-oxygen samples, the Van Slyke manometric apparatus was used throughout.

*Results.* The values of nitrogen excretion have been plotted against body surface area and body weight. The former is shown in Fig. 1. The coefficients of correlation are:

**Nitrogen excretion and Surface Area: r = +0.797, S.E. ± 0.067**
**Nitrogen excretion and Body Weight: r = +0.800, S.E. ± 0.066**

The regression formulae calculated are:

Nitrogen excretion (cc) = 96.5 Body Surface Area (sq.M) +35, S.E. ±25
Nitrogen excretion (cc) = 1.82 Body Weight (kg) + 76, S.E. ± 25

*Discussion.* The method for the determination of nitrogen excre-

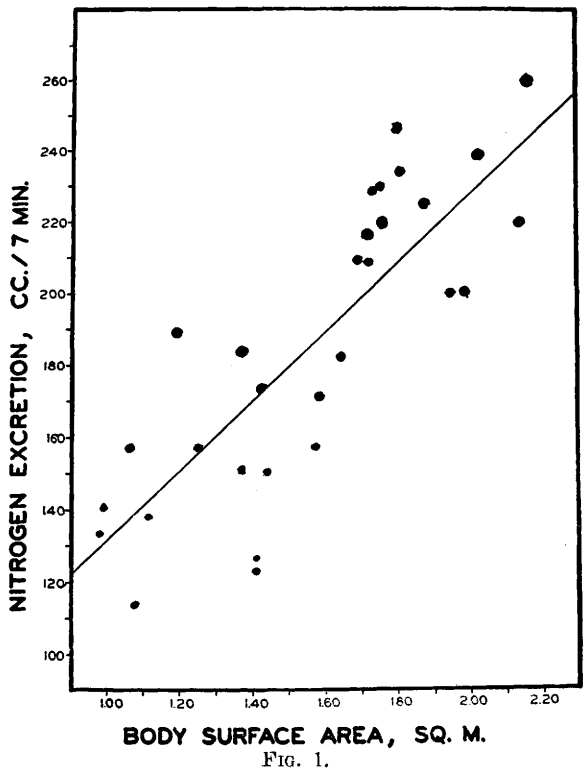


FIG. 1.

tion which was used here,[5] proved to be fairly precise. Out of 30 subjects on whom nitrogen excretion was determined, 18 were done in duplicate. The greatest difference among duplicates amounted to 56 cc and only 5 showed a difference greater than 25 cc.

In all of our experiments, the average alveolar nitrogen concentration, after the preliminary washing period, was 3.51% with a standard deviation of ±2.11 and a range from 1.30% to 9.51%. The nitrogen washed out subsequently, therefore, came mostly from the blood and tissues and only in very small amounts from the residual air. This fact undoubtedly helps to explain the fairly high precision of the method.

The maximum error in the determination of residual air by the open-circuit method, due to the calculation of nitrogen excretion from our regression formulae, would be 95 cc $\left(\frac{3 \times 25}{0.8}\right)$. In 68% of the cases it would not exceed 30 cc $\left(\frac{25}{0.8}\right)$.

In Fig. 2 the regression line (solid) of nitrogen excretion against body surface area has been drawn with lines (broken) parallel to it

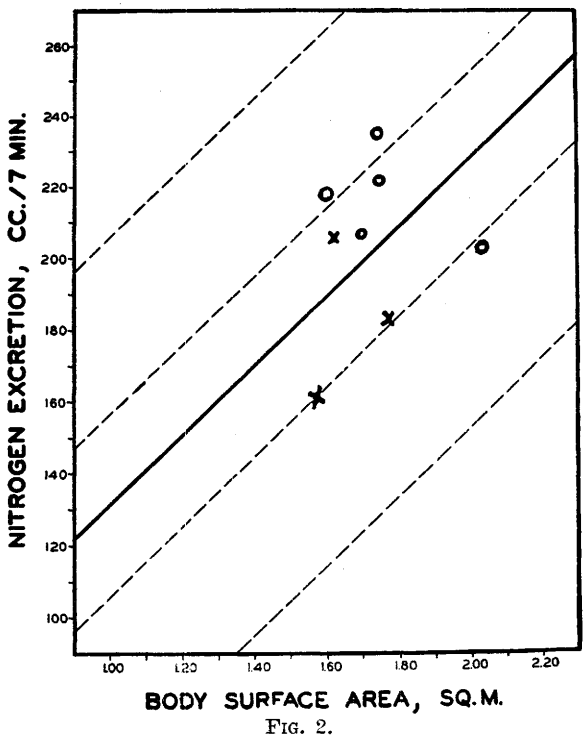


FIG. 2.

representing the limits of the standard error of our equation and 3 times the standard error. The values for nitrogen excretion during a 7-minute period of pure oxygen breathing calculated from the data of Campbell and Hill[3] (open circles) and Behnke, Thomson and Shaw[4] (crosses) have been plotted. As can be seen, 62% (5/8) of the points fall within the limits of the standard error while the rest fall easily within 3 times the standard error.

*Summary.* 1. The volume of nitrogen excreted from the body by way of the lungs, when a subject breathes pure oxygen for short periods, is found to vary with the size of the individual. 2. The nitrogen excretion during 7 minutes of oxygen breathing has been determined in 30 normal individuals of various ages and sizes. The values obtained have been correlated with body weight and with surface area. Coefficients of correlation and regression equations are given.

13298 P

## Electromyographic Studies on Recoördination of Leg Movements in Poliomyelitis Patients With Transposed Tendons.*

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Man, in contrast to lower mammals,[1] can retime the action phase of a transposed muscle in accordance with its new function. Just how this occurs, is largely unknown. A systematic investigation of "recoördination," therefore, offers points of great theoretical and practical interest. A first report of our results is herewith presented.

*Technic.* The muscular action potentials were amplified in an ordinary vacuum tube amplifier set and recorded by an electromagnetically driven stylus writing on "Teledeltos" paper. Before entering the recorder, the amplified action currents passed through rectifying and integrating sets, partially summating and integrating individual spikes so as to give an estimate of the intensity of the con-

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† With the invaluable and most gratifying coöperation of Dr. C. Howard Hatcher, Department of Surgery, and Mrs. Margaret C. Winters, Physiotherapy.

1 Rat—R. W. Sperry, *J. Comp. Neur.*, 1940, **73**, 379. For full review of the problem, see P. Weiss, *Comp. Psychol. Monogr.*, 1941, **17**, No. 4.