tion. It was concluded that this action was local. In several experiments in which sodium sulphide was injected into the fourth ventricle, immediate, well sustained and marked augmentation of ventilation invariably occurred.

Sodium carbonate produced marked apnea when injected into the carotid arteries on both the denervated and innervated side. Injection of sodium bicarbonate on either side produced the typical augmentation of ventilation. After double vagotomy and double carotid sinus denervation, intravenous injection of sodium carbonate produced apnea. Administration of carbon dioxide in a 30% oxygen mixture after double vagotomy and occlusion of the carotid sinuses elicited strong stimulation of the respiratory muscles. Exterior flooding of the carotid sinus with bicarbonate or carbonate solutions appeared to have no effect on pulmonary ventilation.

The relatively small increase in ventilation produced by intravenous injection of cyanide and sulphide after vagotomy and double carotid sinus denervation agrees with the small increase in ventilation under similar conditions on administration of nitrogen as noted by Bouckaert, Dautrebande and Heymans.[1]

Our findings that denervation had relatively little effect on the action of sodium carbonate, sodium bicarbonate and carbon dioxide call for special consideration of a dual mechanism of control of ventilation by oxygen lack and carbon dioxide excess in addition to a possible common mechanism of control.[2]

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Electrocardiographic Study of Movements of the Heart with Change of Posture.

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The human electrocardiogram, as recorded, leading off from points on the surface of the body, is influenced by extracardiac factors, particularly by the effects of the tissues about the heart and

[2] Since this report has been in press our attention has been called to similar experiments in which sodium cyanide and sodium sulphide were injected into both common carotid arteries with denervation of the carotid sinus on one side. Heymans, Bouckaert and Dautrebande. *Archives Internationales de Pharmacodynamie et de Therapie*, 1931, **40**, 54.

the relation of the heart to the surrounding tissues. It is possible for a variation in the electrocardiogram to occur by a change in the extracardiac relations, even though the processes within the heart remain unaltered. Several observers have noted a variation in the form of the electrocardiogram on change of position of the body from the reclining to the lateral positions. There is no agreement as to the type and degree of the alterations nor as to the mechanism underlying these changes. The previous observations have been limited to a small group of subjects and no analysis of a sufficiently large number exists to justify definite conclusions.

In the present study, electrocardiograms were made of 60 individuals in 3 positions, in the reclining, in the left lateral and right lateral positions. The material consisted of normal subjects and of cardiac patients in whom a fixed heart was improbable, such as cases of hypertension heart and coronary disease. The latter were included to determine the effect of cardiac enlargement. The influence of such factors as habitus of the individual, size and displacement of the heart, was noted. Of the 60 cases, 55, or 91%, presented some definite electrocardiographic alteration on change of position of the body. In 5 cases the records were similar in the 3 positions. The change in the form of the electrocardiogram affected

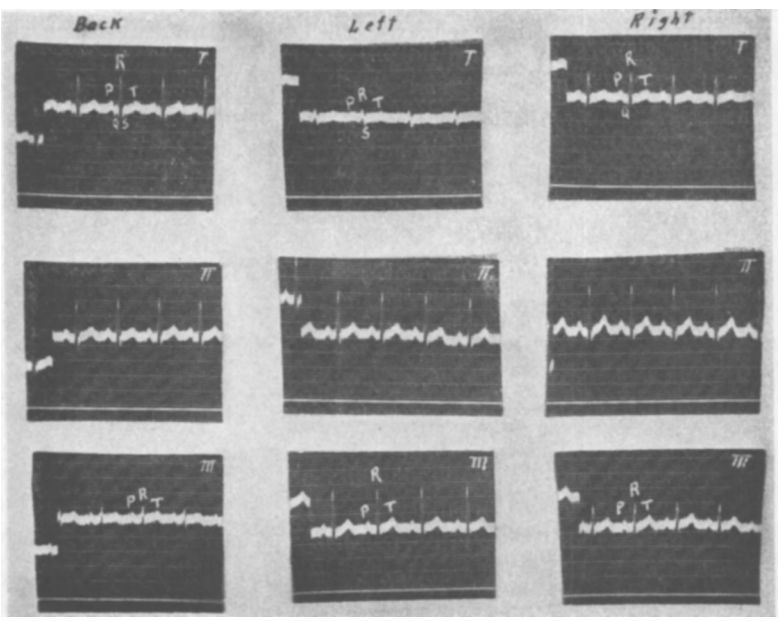

FIG. 1.
Leads 1, 2 and 3 of a normal individual in the 3 positions.

chiefly the QRS wave, although frequently the other waves were modified in the same direction but to a lesser degree. The most marked change was present in the first and third leads, the second lead usually being but slightly affected. These modifications in the amplitude and direction of the QRS can be expressed as variations in the degree of ventricular preponderance. Thus, following the usual terminology, any reduction of the R and increase of the S in lead 1, or increase in the R and decrease of S in lead 3 may be termed a change towards right preponderance. Any alteration of the waves in the opposite directions may be considered as a deviation toward left preponderance.

The most constant and marked changes occurred when the subject was turned from the reclining to the left lateral position. (Fig. 1.) With this procedure, the electrocardiogram altered in the direction of right preponderance in 83% of the cases, towards left preponderance in 6% and was unaffected in 11%. On shifting from the back to the right lateral position, the changes were less constant and usually less marked. In 30% there was no variation in the form of the electrocardiogram as compared with the record taken in the reclining position. Of the remaining 70% one-half changed in the direction of right preponderance and the other half deviated toward left preponderance.

In explanation of these electrocardiographic findings, the only

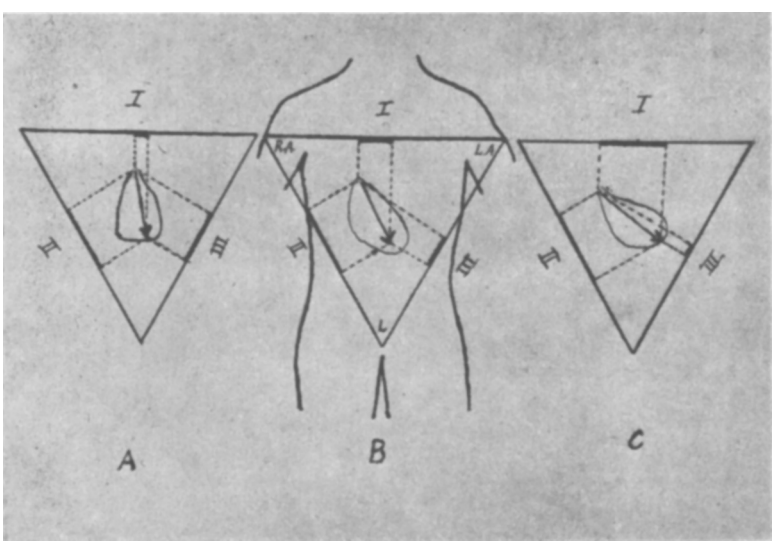

FIG. 2.
The schema of the equilateral triangle showing the effects of rotation of the heart about the anterior posterior axis.

extracardiac mechanism of sufficient influence to produce such changes is a shift in the position of the heart with the change in body position. Einthoven, Fahr and deWaart[1] have demonstrated that the effects of rotation of the heart as viewed in the frontal plane may satisfactorily be explained by the application of a schema in which the human body is represented by a plane in the form of an equilateral triangle. (Fig. 2, B.) The apices correspond to the right arm, R. A., left arm L. A. and both legs L, from which the current is led off to the galvanometer. The heart is in the center of the triangle and if a line drawn through it representing the direction of difference in potential, is projected on each side of the triangle, the proportional amount of current tapped by each lead is recorded. It is obvious from inspection of the triangles that rotation of the heart about the anterior-posterior axis will produce profound changes in the amplitude of the waves, especially in leads 1 and 3. (Fig. 2, A and C.) With the application of this method it is possible to interpret the changes in amplitude and direction of the QRS in leads 1 and 3 in terms of rotation of the heart. Thus, with the heart relatively fixed at the base and comparatively free at the apex, a change in the direction of left preponderance indicates a rotation of the heart about an anterior-posterior axis to the left (Fig. 2, C), while a change towards right preponderance indicates a rotation to the right. (Fig. 2, A.) Applying this to the findings noted in this report, it is clear that rotation of the heart about the anterior-posterior axis will not explain them, since the left lateral position resulted in a tendency to right preponderance in 83% of the cases. The possibility that upward displacement of the left diaphragm in the left lateral position could rotate the heart to the right sufficiently to account for the right preponderance needs little consideration. Roentgenologic studies of the chest in the 3 positions exclude such a possibility unless it be in very exceptional cases.

The effects of rotation of the heart about the longitudinal axis have been studied by 2 groups of investigators. Boden and Neukirch[2] found that rotation of the isolated perfused heart about the long axis to the left resulted in a tendency to right preponderance, while rotation to the right gave opposite effects. Meek and Wilson[3] arrived at the same conclusions in their studies upon the intact animal. Thus it is clear that the 2 possible types of rotation of the

[1] Einthoven, W., Fahr, G., und deWaart, A., *Arch. f. d. ges. Physiol.*, 1913, **150**, 275.

[2] Boden, E., und Neukirch, P., *Arch. f. d. ges. Physiol.*, 1918, **171**, 146.

[3] Meek, W. J., and Wilson, A., *Arch. Int. Med.*, 1925, **36**, 614.

heart associated with a change from the reclining to the lateral positions have opposite electrical effects.

With this in mind, the analysis of the findings in the present report indicates that on the change from the reclining to the left lateral position, the electrical effects of rotation about the longitudinal axis predominate in most instances, with occasional predominance of the effects of rotation about the anterior posterior axis. In approximately 10% the 2 opposite effects exactly neutralize one another as indicated by the absence of any alteration in the electrocardiogram. In the shift to the right lateral position there is approximately an even distribution of the effects, each type of rotation predominating in one-third of the cases and a neutralization of the effects in the remainder.

These studies suggest that some care must be observed as regards the position of the patient in the taking of electrocardiographic records. It is possible in many cases that a moderate rotation of the body, especially to the left, may sufficiently alter the record as to result in error, particularly in the interpretation of ventricular preponderance. These observations also indicate that an absence of variation in the electrocardiogram with change of posture is not invariable evidence of a fixation of the heart.

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A Rat Board for X-Ray, Photography, and Operative Procedure.

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The board for holding rats, shown in the accompanying illustration, will be found convenient for x-ray exposures, photographs or for an operating board. It was designed to obviate the danger to the workers of exposure to x-rays. We calculated that the number of exposures necessary was in excess of the dosage compatible with safety. With the present device, one person can do the work for which 3 were formerly required. The animal is placed in the holder outside the x-ray room and while the exposure is made, a second animal is made ready. Thus no worker is exposed to x-rays.

The apparatus shown was made from sheet aluminum. It can be made of steel or covered with lead as desired. The clips are battery