

bundle branch block no gallop rhythm was present; the first and second heart sounds showed normal time relations.

We have seen one instance in which 2 extra sounds, one of which was linked to the first and the other to the second heart sound fell together at the usual heart rate and gave rise to a very pronounced gallop on auscultation. When the heart rate was slowed by pressure upon the carotid artery these 2 sounds were separated.

In complete and in high grade partial heart block auricular sounds are as a rule easily recorded. Very frequently each auricular contraction produces 2 sounds. The intensity of the auricular sounds varies greatly with the relation of auricular to ventricular systole; they are often very loud when the P-deflection of the electrocardiogram falls near the end of the T-wave. In one case of complete heart block auricular sounds occurred during ventricular systole as well as in diastole, indicating that auricular contraction may produce a sound even when it expels no blood into the ventricles.

In some cases of complete heart block the R-T interval of the electrocardiogram is nearly twice as long as the length of systole measured from the beginning of the first to the beginning of the second heart sound. Less pronounced discrepancies between the R-T interval and the length of mechanical systole were observed when the cardiac mechanism was normal.

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Electrocardiographic Leads Which Record Potential Variations Produced by the Heart Beat at a Single Point.

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In a recent publication¹ we have shown that if the assumptions upon which Einthoven's equilateral triangle is founded are valid the potential of the right arm (V_R), the potential of the left arm (V_L), and the potential of the left leg (V_F) at any given instant in the cardiac cycle are defined by the following equations:

¹ Wilson, F. N., Macleod, A. G., and Barker, P. S., *Am. Heart J.*, 1931, **7**, 207.

$$V_R = -\frac{e_1 + e_2}{3} \quad (1)$$

$$V_L = \frac{e_1 - e_3}{3} \quad (2)$$

$$V_F = \frac{e_2 + e_3}{3} \quad (3)$$

where e_1 , e_2 , e_3 represent the deflections in standard leads I, II and III respectively at the chosen instant. It will be seen that at every instant

$$V_R + V_L + V_F = 0. \quad (4)$$

Let suitable electrodes be placed upon the right arm, left arm and left leg in the same manner as in taking ordinary electrocardiograms and let these electrodes be connected, each through a resistance R , to one and the same terminal. Providing that the 3 resistances (R) are equal and sufficiently great so that this procedure does not materially alter the potential variations produced by the heart beat at the extremities, it may be shown that the potential of this central terminal will not be significantly influenced by the heart beat and may be taken as zero throughout the cardiac cycle. If an instrument which has a resistance sufficiently high so that it may be regarded as a potentiometer is connected to this terminal and to any body point, it will record the potential variations produced by the heart beat at the latter point. In this way V_R , V_L and V_F may be directly recorded by connecting the recording instrument to the central terminal and the electrode in contact with the proper extremity, and the characteristics of the electric field set up in the body by the heart beat may be easily investigated. Lead V_L , as indicated by equation (2), gives a direct measure of the index employed by Lewis,² White³ and others for determining the grade of right or left preponderance present.

The statement that the potential of the central terminal is not influenced by the heart beat is easily proved in the following way. Let V_0 represent the potential of this terminal. If the currents flowing from the right arm, the left arm and the left leg toward the central terminal are represented by I_R , I_L , and I_F respectively, we have the equations

$$V_0 = V_R - RI_R \quad (5)$$

$$V_0 = V_L - RI_L \quad (6)$$

$$V_0 = V_F - RI_F \quad (7)$$

² Lewis, Thomas, *Heart*, 1913-14, 5, 398.

³ White, P. D., "Heart Disease", The Macmillan Co., New York, 1931.

By adding these equations we obtain

$$3V_0 = V_R + V_L + V_F - R(I_R + I_L + I_F) \quad (8)$$

The expression enclosed in parenthesis is obviously equal to zero by Kirchhoff's first law, which states that in any network the algebraic sum of the currents meeting at a point is zero. Consequently, by equation (4) the right hand member of equation (8) is equal to zero and V_0 is not influenced by the heart beat.

In our experiments we have connected each of the 3 extremities to the central terminal through a non-inductive resistance of 25,000 ohms. In order to convert the string galvanometer into a potentiometer we have inserted a vacuum tube in the string circuit. In doing this we have adopted the method employed in Dr. W. J. V. Osterhout's laboratory and we wish to thank Dr. S. E. Hill for his kindness in supplying us with the necessary data.

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Cultivation of Herpes Virus, and Use of the Mouse in its Titration.

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Parker and Nye¹ attempted, unsuccessfully, to cultivate the herpes virus. Rivers² and his coworkers, using rabbit cornea embedded in rabbit plasma, were, however, more successful, and later, Gildemeister³ and his associates grew the virus over 22 successive generations, their medium being rabbit testicle in rabbit plasma. The most recently published work in this connection has been that of Andrewes,⁴ who reported successful cultivation of the herpes virus over 23 successive generations.

We have recently successfully cultivated the H. F. strain of herpes virus through 25 generations. The medium used has been similar to that of Andrewes. Three cc. of Tyrode's solution and

¹ Parker, F., Jr., and Nye, R. N., *Am. J. Path.*, 1925, **1**, 337.

² Rivers, T. M., Haagen, E., and Muckenfuss, R. S., *J. Exp. Med.*, 1929, **50**, 665.

³ Gildemeister, E., Haagen, E., and Scheele, L., *Zentr. f. Bakt.*, Abt. 1, 1929, **114**, 309.

⁴ Andrewes, C. H., *J. Path. and Bact.*, 1930, **33**, 301.