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DETERMINATION IN THYROID DISORDERS

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THE CLINICAL SIGNIFICANCE OF ELECTRICAL IMPEDANCE DETERMINATION IN THYROID DISORDERS*

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Interest in the relationship between the phase angle of the electrical impedance of the human body and thyroid disturbances has been prompted by the recent work which Brazier (1), (2), (3), (4) has reported in England. During the past year the American Goutier Society granted Brazier its first award for her contribution to the study of thyroid disorders. Furthermore, at the present time an apparatus of the type described by Brazier is being offered for sale in England as a diagnostic instrument for use in thyroid disease. According to the publication of this author it is possible to follow the clinical course of thyroid disease very accurately, using this electrical measurement as the basis for the estimation of thyroid activity. Since impedance values are little affected by food, activity, menstrual cycle and so forth, it appeared that this measurement might offer advantages over metabolic rate determinations.

The earliest attempts to measure the impedance of the human body were made with direct current. Using a direct current, the impedance offered by the body to the current has but a single component, namely, the resistance. However, when an alternating current is employed, the body conducts the current as would a circuit containing both a resistance and a capacitance. In other words it exhibits both resistance and reactance. The ratio of the values of these two components is a property of the tissues under observation. Brazier believes this property to be a function of thyroid activity. The ratio of the reactance to the resistance Brazier defines as the "Impedance Phase Angle." Inasmuch as this ratio is not represented by an angle in conventional electrical engineering practice we shall avoid the use of this expression. Instead we shall follow the notation, already well established, in which this ratio is designated as the factor "Q."

The method of making electrical contact to the body recommended by Brazier involves immersing the arms to the elbows in saline solution. It is claimed that by thus making the area of the surface tissues relatively large their effect upon the impedance measure is negligible. That this is far from true has been demonstrated by Horton and VanRavenswaay, who have developed a method for measuring separately the impedances of the surface sheath and of the internal tissues. The method used by them involves the use of four electrodes which, in effect, form the terminals of a multiple branch electrical network. Certain of the branches being due solely to surface tissues and others solely to internal tissues the evaluation of

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each may be effected by computation from measurements of the impedances between the several possible pairs of terminals. There has also been developed an impedance comparator, employing the principle of the alternating current potentiometer, by which it is possible to obtain by direct measurement the values of the

resistance and of the reactance components of the surface sheath areas under each of two electrodes and of the internal tissues joining these areas.
 Data obtained by the four electrode method, both with the comparator and by the direct measurement on the several electrode pairs, lead to the following conclusions. A detailed discussion of this part of the work is given in another paper (5).
 (1) The characteristic curves showing the variations of the impedance components with the frequency for the surface sheath are markedly different from those for the internal tissues.
 (2) The value of Q for the surface sheath, at 10 kilocycles, may vary between

Fig. 1. Impedance values of treated and untreated thyrotoxic patients at different metabolic levels.

