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Correlations between Epidermal Impedance and the Clinical Course in Certain Psychoses.

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No objective, experimental method has, as yet, been described for accurately estimating the clinical level in mental disease. Although the outward manifestations of a swing from catatonic stupor to catatonic excitement in a schizophrenic or from a manic to a depressed state in a cyclothemic may be very striking from the standpoint of an observer, we remain in comparative ignorance of the basic processes producing these changes. The purpose of the present paper is to describe a simple, objective, quantitative method which appears to follow variations in the clinical state in certain types of mental disease with considerable fidelity and which, at the same time, shows promise of throwing light on the underlying processes responsible for the changes observed.

In the course of impedance measurements carried out on all of the adult mental patients (about 125) hospitalized at the N. Y. State Psychiatric Institute and Hospital, it was observed that when certain patients became violent, markedly disturbed or confused, necessitating transfer to the agitated wards, the skin impedance values showed a decrease which in many cases was very marked and that, contrariwise, when the same patients calmed down or improved sufficiently to permit transfer back to a non-agitated ward, the measured impedances showed a counter-swing towards and even above their original levels. It was observed, moreover, that the patients exhibiting this phenomenon fell into no specific diagnostic group, catatonics, cyclothemics, involutionals and even organic psychoses each contributing their quota.

The evolution of the impedance values in 7 of these cases is shown in the accompanying figure. Measurements of the epidermal impedance were made on the posterior and anterior surfaces of the right upper arm by the 3-electrode method at 11,160 cps, as previously described,[1, 2] using an annulus having having a surface area of 6 cm^2. The means of the posterior and anterior values are plotted in the various curves.

1 Barnett, A., *J. Physiol.*, 1938, **93**, 349.

2 Barnett, A., *West. J. Surg.*, 1937, **45**, 540.

All of the cases shown, although of widely varying clinical character, present essentially the same features in the evolution of the impedance curves; (1) during periods of increasing excitement, agitation or resistiveness, the curves descend; (2) during periods of depression, quiet or recovery, the curves ascend.

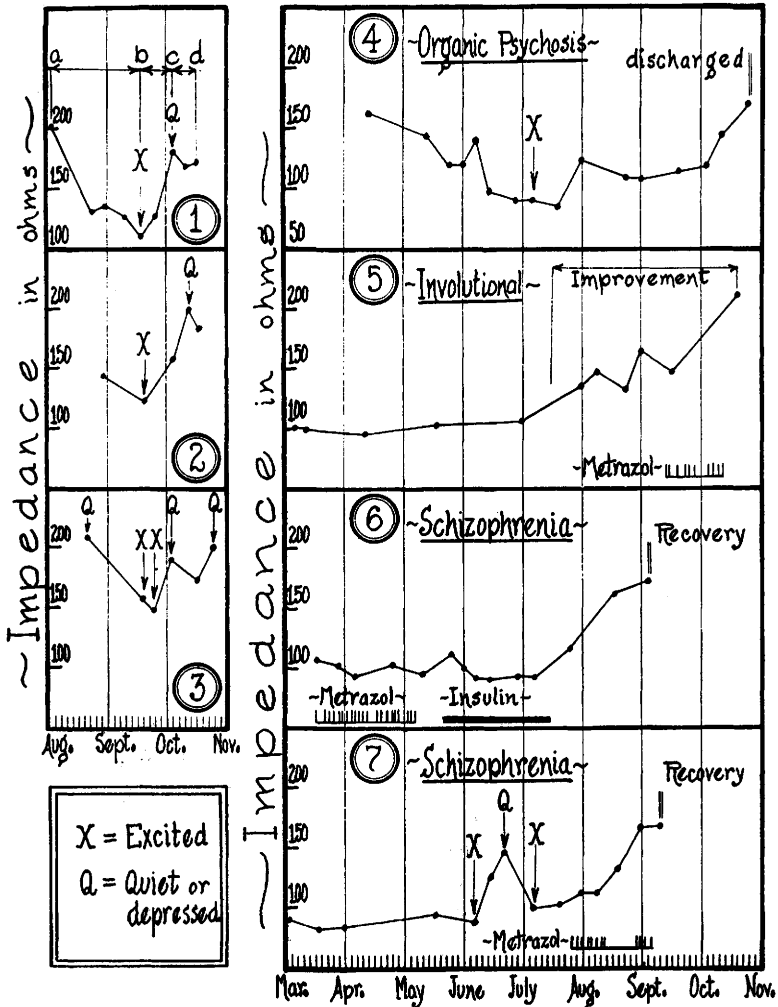

FIG. 1.

Correlations between epidermal impedance and the clinical course in mental disease.

Ordinates, impedance in ohms. Abscissæ, time in days, each subdivision represents a 3-day period. The electrode area is 6 cm^2.

The numbers in each rectangle correspond to the case numbers given in the text. In cases Nos. 5, 6 and 7, the number and spacing of the metrazol treatments is indicated by a short vertical line on each day of treatment.

An analysis of case No. 1 will serve to illustrate these changes. This patient, presenting a pure manic-depressive syndrome accompanying the menopause was admitted in a relatively quiescent state. During the 3 weeks following, she became more and more excited, talking and shouting constantly. These changes were reflected in the impedance curve by descending branch *a-b*. Very suddenly and at the height of the period of excitement, the patient entered a quiet phase, *b-c,* in which she spoke in reserved tones and conducted herself in a perfectly normal manner. The impedance curve moved upward during this period to plateau level *c-d,* where it remained until her discharge.

Cases No. 2 and No. 3 present a similar parallelism between the course of the impedance curves and the clinical state. The diagnosis in case No. 2 (male, age 16) was hesitant as between an early schizophrenia (catatonic) and cyclothemia. In case No. 3 (male, age 26), a history of chronic purulent otitis and findings of marked variability in the pressure and the protein content of the spinal fluid associated with suggestive neurological signs made the diagnosis undecided as between an organic psychosis (possible brain abscess) and schizophrenia (catatonic). Both of these cases were in full clinical evolution at the time of the present writing.

Cases No. 4 to No. 7, inclusive, are given to show clinical-impedance correlations where changes in the clinical course take place over a protracted period.

Case No. 4 (male, age 33) is that of a Parkinsonian with a psychosis having the characteristics of a catatonic schizophrenia. It may be regarded as organic. This patient presented a gross tremor of the right hand and arm exaggerated by intentional movements and a marked hypertonus of the muscles of the leg on the same side (cog-wheel rigidity). The psychosis included hallucinatory, confusional, negativistic and excitatory symptoms which, beginning in mid-April, rose to a maximum early in July, at which time the patient had to be tube fed and would remain standing in one spot for hours in a position of extreme opisthotonus. Improvement took place along the ascending branch of the impedance curve until the time of his discharge, incompletely recovered, in late October. The impedance curve, here, is an excellent representation of the clinical course.

Case No. 5 (female, age 53) is an involutional melancholia in which symptoms of agitation predominated. The clinical state as well as the impedance curve remained at a substantially stationary level from March to July. This was followed by a moderate spon-

taneous improvement over the period of the next 2 months which permitted transfer of the patient from an agitated to a non-agitated ward. A series of metrazol treatments were then given which resulted in further and more rapid improvement. The impedance curve, here again, reflects very well the clinical course.

Case No. 6 (female, age 39) is a schizophrenia (catatonic) in which the clinical state as well as the impedance remained at a stationary level over a period of about 4 months, during which time there were frequent outbreaks of violence. A course of metrazol treatments given during this period had little effect and was followed by insulin shock treatment. Some improvement became apparent near the end of the insulin series and accentuated itself during the month following. The upward course of the impedance curve follows the clinical improvement with considerable fidelity.

Case No. 7 (female, age 33), a schizophrenia (catatonic-paranoid), shows an impedance curve with a peaked portion occurring in the month of June. A marked improvement was observed at the maximum of this peak, but shortly thereafter, the patient's condition reverted to its former state (downward portion of curve) with signs of deterioration (playing with feces, smearing of food on arms and face). A course of metrazol was then given with progressive improvement and recovery as shown by the upward course of the impedance curve during August and early September.

Because of the fact that the total impedance change may cover a range of as much as 100% (case No. 4), measurements of the phase angle of the skin were also made[1] in each case to determine whether any marked variation in the ratio between the reactive and resistive components accompanied the change in impedance. All of the phase angle values fell between 69° and 75° and the maximum change in any case was 4°, corresponding to a variation in the ratio between the reaction and resistive components of only 2-3%.

Finally, as a cross-check on the epidermal impedance measurements, Q-factor readings were taken on the arm-to-arm segment of each patient both by the immersion[3] and 4-electrode methods.[4, 5] Q-factor determinations by the immersion method include a skin component contributing about 60% of the total reactance[3, 5] and changes in skin impedance would show up in the total Q-factor measurement, provided the variations in the Q of the deep tissues remained small.[4] Whenever this was found to be the case, for each change of

[3] Barnett, A., *West. J. Surg.*, 1937, **45**, 380.

[4] Barnett, A., *West. J. Surg.*, 1937, **45**, 612.

[5] Horton, J. W., and Van Ravenswaay, A. C., *J. Frankl. Inst.*, 1935, **220**, 557.

epidermal impedance, a corresponding shift in the Q-factor (immersion) was found to take place.

Discussion. The findings here reported are of a preliminary nature and do not permit a judgment, as yet, as to how generally impedance readings of this type reflect changes in the clinical state. The cases selected for presentation were chosen, largely, because they included an agitated phase and the clinical changes were so marked in character as to admit of no doubt in the minds of a number of observing clinicians. Whether or not, as a result of further studies, impedance readings be found to follow changes in the clinical state as a general rule, the group of cases here presented may be considered to constitute evidence for the existence, in certain mental patients, of an impedance syndrome characterized by a parallel evolution of the epidermal impedance values and the clinical course. This syndrome may be separated from the general body of the psychoses for special study and may throw considerable light on the mechanisms responsible for this particular clinical entity.

The relative constancy of the phase angle of the skin during an impedance variation of as much as 100% rules out any possibility of the direct current resistance of the skin being responsible for the impedance change. Impedance changes are best explained as representing corresponding variations in thickness of the epidermis.

Summary. In certain forms of mental disease, the epidermal impedance is found to reflect variations in the clinical course, the values decreasing during phases of agitation and increasing during periods of quiet, depression or recovery. The phenomenon is not limited to any diagnostic group and may be found among catatonics, cyclothemics, involutionals and even in the organic psychoses.