Editorial

Clinical Electrocardiography: Offspring of Science or Empiricism?

Nearly all clinical electrocardiographers now employ the 12-lead electrocardiogram as standard or at least basic procedure. The 9 leads designated "unipolar" are regarded as superior to "bipolar" leads, save for Einthoven's limb leads, which are credited with special values revealed by his equilateral triangle hypothesis. But if the present conformity in technic reflects widespread satisfaction with things as they are, the results of newer investigations of theory and recent studies of the consequences of ischemia in certain parts of the heart, as well as older matters sometimes swept under the rug, invite inquiry into the present state of affairs.

The assumption that patterns of potential fluctuation transmitted to an electrode in contact with the heart, can be recorded without serious degradation in electrocardiograms, provided the other electrode is placed away from that organ, although contested in the past, has long been widely accepted. But when electrode positions are limited to the body surface, the possible approaches toward such an objective appear to be (1) finding a reference position where potential fluctuations are relatively small and (2) the use of devices to achieve partial or complete cancellation of potentials from 2 or more positions. The acceptance of centripetal dipole hypothesis, even to the limited extent of accounting for the distal body surface potentials, should move one toward the second approach. This is the approach of the Wilson procedure, which by deriving its theoretical basis mainly from Einthoven's historic hypothesis attempts a complete or practically complete cancellation as implied by the term "unipolar lead."

Einthoven and Wilson conformed to scientific procedure when they stated the assumptions, mostly untested, upon which they based their hypotheses. The fact that this state of affairs imparted a provisional status to unipolar lead theory, appears to have escaped mention by most writers on clinical electrocardiography. V-lead values can be derived from lead systems in which an electrode attached to the right arm, left arm, or left leg is substituted for the central terminal in precordial leads, provided the values of leads I and II are known and time relations are taken into account. Thus because the basic data of the 12-lead electrocardiogram are found in 8 other leads, it is repetitious to a degree and claims for its superiority must rest upon the arrangement of differences of potentials in what is regarded as a unipolar form. Exploration of the body surface using V leads has reflected what appears to be a complex state of affairs so far as the distribution of ventricular potential is concerned and has provided recommendations for numerous leads to supplement the 12-lead electrocardiogram. The phenomenon of "decrement" or preservation of patterns of differences of potential varying in minor degree save for amplitude of deflections is observed over limited areas only, unless limb leads are of small amplitude. Such findings are in striking contrast with those obtained when the reference electrode is placed over the right upper part of the back, by which large areas where decrement exists can be demonstrated with corresponding reduction in variety of ventricular patterns and simplification of relationships. Finally the uniform distribution in V leads of the "unexplained deflection" of right bundle-branch block over an area that
includes the right side of the precordium and the right arm, in contrast with decrement in the other deflections of the QRS complex, has not been reconciled with unipolar lead theory.\textsuperscript{2}

Irrespective of these phenomena, unipolar lead theory requires examination at the level of its essential assumptions. With respect to the important assumption of homogeneous conduction, various attempts have been made to measure the resistivity of living tissues in situ. To what extent the technical difficulties of such measurements have been solved, remains to be decided by those competent in this pitfall-laden field. A conclusion upon that point is a necessary preliminary to evaluation of error in unipolar theory introduced by this assumption, not only in the light of well known differences in blood versus tissue resistivities but because of their structural relationships, especially in the heart and lungs. In the past, questions regarding dipole eccentricity as a possible objection to Einthoven's hypothesis were usually dismissed as quibbles. Nevertheless, theoretical analysis by Frank and studies in models by Frank and Kay (in experiments that accept the conditions of a finite dipole and homogeneous conduction) have shown that central terminal technic should exhibit an important deviation from unipolarity in human beings because of dipole eccentricity.\textsuperscript{3} Thus, one of the essential theoretical supports, not only for unipolar lead technic, but also for certain long-cherished notions regarding limb leads, has become dislocated. If this is all that is seriously wrong with unipolar lead theory, the possibility of salvage exists. In fact, if by appropriate corrections phenomena now almost quantitatively predictable from limb leads, such as the unexplained deflection and the uniform S-T segment displacement sometimes recorded in all precordial leads, could be eliminated, the unipolar thesis would be relieved from the burden of accounting for an influence of limb leads upon precordial leads.

Sufficient time has not yet elapsed for careful examination of the new cancellation technics designed to demonstrate the existence of “mirror” (actually inverse) patterns of potential. One may venture to predict that not all will surrender promptly to the implication of finality suggested by this work. Already the comparably good cancellations obtained by different methods based upon somewhat different theoretical concepts appear to require explanation.

What can be said regarding the various vectorcardiographic procedures recently proposed? For one thing, the basic assumptions are too divergent for all these procedures to be equally firmly grounded, and without new evidence we shall not know whether any is. There seems little reason for objection to the proposal of a vectorcardiographic or electrocardiographic procedure for clinical use without reference to theory, if one is prepared to defend his procedure upon practical grounds such as the correlation of findings with subsequent adequate pathologic data. Indeed until theory is further advanced, there seems no alternative course by which any technic proposed for clinical use can be justified.

We cannot at present dispose of the question raised in the title regarding the relative contributions of science and empiricism, and, one might add, incompletely validated hypothesis to clinical electrocardiography where only results count. But whenever better methods can be developed than those sanctioned by particular notions concerning theory, so much the worse for such notions. For there seems little doubt that when sound theory is established there will be little difficulty in recognizing the best methods.

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\textbf{REFERENCES}


\textsuperscript{2} — and —: A study of methods of making so-called unipolar electrocardiograms. Am. Heart J. \textbf{27}: 764, 1944.

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