REPORT OF COMMITTEE ON ELECTROCARDIOGRAPHY, AMERICAN HEART ASSOCIATION

Recommendations for Standardization of Electrocardiographic and Vectorcardiographic Leads

Committee Members: Frank N. Wilson, M.D., Honorary Chairman†
Charles E. Kossmann, M.D., Chairman, George E. Burch, M.D., Emanuel Goldberger, M.D., Ashton Graybiel, Captain, MC, USN, Hans H. Hecht, M.D., Franklin D. Johnston, M.D., Eugene Lepeschkin, M.D., Gordon B. Myers, M.D.

It was 16 years ago that the first Joint Recommendations of the American Heart Association and the Cardiac Society of Great Britain and Ireland on the Standardization of Precordial Leads were published. The report, expertly done by selected committees of each of these organizations, was received with considerable enthusiasm by most clinicians, with some misgivings by a few. The latter included those individualists to whom the word standardization is anathema, and to whom conventionalization is synonymous with stultification of thought.

In the years since the report appeared, the concern of the dubious has not been justified. Investigation of new leads and new techniques has gone ahead at a good pace. It is doubtful that the standardization has inhibited any investigator from continuing his search for the truth by whatever electrocardiographic method he pleases to use.

On the other side of the question, the mutual agreement on techniques and nomenclature has greatly facilitated the clinical use of the electrocardiographic method. Certainly before 1938 the state of precordial leads was chaotic so far as the average practitioner of medicine was concerned. The standardization helped bring a surprising degree of order out of the confusion to the gratification and benefit of physicians and patients alike. It undoubtedly led to many systematic electrocardiographic studies, especially during World War II, which may never have been undertaken or which would not have been easy to compare with other studies by reason of widely varying techniques of recording.

The standardization was not meant to be rigid and unchanging as witness the two supplementary reports on precordial leads and the report on electrocardiographic nomenclature of the American Heart Association, a report on multiple unipolar leads by a committee of the British Cardiac Society, and the Recommendations Concerning the Use of Precordial Leads of the German Society for the Study of the Circulation. More recently the fifth edition of the Nomenclature and Criteria for Diagnosis of Diseases of the Heart and Blood Vessels has come off the press. Most of the electrocardiographic section concerned with instruments, techniques, and nomenclature, composed by a committee of the New York Heart Association, has been incorporated in the present report. Nevertheless it seemed that the time had come to review the entire subject again, to include vectorcardiography, and to make such recommendations as might seem appropriate in the light of new knowledge and recent additions to old knowledge. Toward this end the present Committee on Electrocardiography of the American Heart Association, after a careful consideration of all of the facts available to it, submits the following recommendations. It will be evident that it has borrowed generously from the excellent reports of previous committees assigned a similar task, and that it has attempted, for obvious reasons, to consolidate all

† Deceased.
previous publications of a similar kind into a single communication.

Electrocardiographic Leads

A. Instruments*

1. Electrocardiographs shall be equipped with a suitable mechanism for making permanent records.

2. The recorded response of the electrocardiograph to externally applied voltages shall be adjustable to a sensitivity of 1 cm. per millivolt when this voltage is applied to the leads of the instrument through a series resistance of 2000 ohms. This sensitivity shall be maintained without further adjustment within ±5 per cent for a minimum period of three minutes under operating conditions. Operating conditions for the purpose of this requirement are defined as follows: (1) For instruments powered by alternating current at a specified power frequency, the line voltage may vary from 105 to 130 volts and the power frequency ±2 per cent from its specified value. (2) For instruments powered by one or more batteries, the voltage across the terminals of any or all batteries, when under operation, should be between 80 per cent and 100 per cent of their rated voltage.

Under these conditions the response of the instrument to its incorporated standardizing signal of 1 millivolt shall be within ±5 per cent of the response to the externally applied test signal. The instrument shall incorporate means of superimposing its intrinsic test signal upon the cardiographic tracing as recorded from any lead position. It must be possible to apply this signal voltage continuously for a period of two or more seconds.

3. The response of the instrument at 0.2 second after the application of a direct voltage of 1.0 millivolt shall not deviate more than ±10 per cent from the response at 0.04 second. The test voltage of 1 millivolt should be applied to the leads of the instrument through a series resistance of 2000 ohms.

4. When the instrument is adjusted for a maximum deflection of 1 cm. in response to a direct voltage of 1 millivolt, the deflection resulting from a sinusoidal voltage of the same magnitude varying in frequency from 1 cycle to 15 cycles per second shall not be less than 0.9 cm., from 15 to 40 cycles per second shall not be less than 0.8 cm., \* from 5 to 300 cycles per second shall not be more than 1 cm., and from 1 to 5 cycles per second shall not be more than 1.1 cm.

5. When the instrument is adjusted to the sensitivity specified in requirement 2, the recorded response shall be directly proportional to the applied voltage (direct current) within ±5 per cent over the entire recording range.

6. With the two input terminals connected together, a potential difference applied between them and ground should not produce a deflection of more than 1 per cent of that produced by the same potential difference applied between the two input terminals.

7. The instrument shall incorporate a means of continuously recording time intervals on the record, and this must be by means of a device operating independently of the record-driving mechanism. These intervals shall be of 1 second duration or less and the timing device shall be accurate within ±2 per cent. However, a means of superimposing this time signal on the electrocardiographic tracing at the operator's wish will be accepted as fulfilling this requirement. It should be possible to record the time signal for a period of at least two seconds. Recording paper prereded so as to indicate time intervals, assuming a constant paper speed, shall not be construed as fulfilling this requirement.

8. It has become increasingly clear that the more or less standard paper or film speed of 25 mm. per second incorporated in most instruments makes it difficult on occasion to resolve certain diagnostic details of rapid electrocardiographic deflections. It is recommended that multiple speeds be made available, or if

* Modified from a report by the Advisory Committee on Electrocardiographs to the Council on Physical Medicine and Rehabilitation of the American Medical Association.7

† The Committee regards these as minimal frequency characteristics applicable principally to portable direct-writing electrocardiographs. Whenever possible the instrument used should have an amplitude response to a sinusoidal voltage considerably in excess of these limits. For a precise study of wave forms, the instrument used should display a flat frequency response from 0.5 to 100 cycles per second as a minimum characteristic.
the instrument provides only one, that this be one of several which the purchaser may select. A speed of 50 mm. per second appears to be particularly useful.

B. Technics

1. General. Changes in the electrocardiogram occur in variable degree with change in posture, after meals, after smoking, after exercise and with the use of drugs. The position of the body at the time the recording is made should be stated in the report. The preferred position of the patient is recumbent. The reclining table should be long enough and wide enough to support all extremities. To eliminate shivering, the temperature of the room in which the records are made should be comfortable. For precise, comparative work the patient should be in the basilar state at each recording.

2. Bipolar Extremity Leads (Standard Leads, Bipolar Limb Leads, Standard Bipolar Limb Leads). Bipolar extremity leads record the difference in potential between two extremities when each is connected to one of the input terminals of the recording device. A lead such as this, in which both electrodes are attached to the body and are relatively equidistant from the heart, is described as bipolar. The difference in potential between the left arm and the right arm is designated as lead I, between the left leg and the right arm as lead II, and between the left leg and the left arm as lead III. In each instance the connections to the galvanometer are to be made in such a way that positivity of the first named extremity with respect to the second results in an upright deflection in the finished record.

In taking these leads the sensitivity of the recording instrument should be so adjusted that introduction of 1 millivolt in the circuit results in a deflection of 1 cm. In practice, this reference voltage or “standardization” should be recorded at the beginning and at the end of each lead.

The electrodes may be placed on any part of the arms or of the left leg in making these leads, so long as they are below the shoulders in the former and below the inguinal fold anteriorly and the gluteal fold posteriorly in the latter. Any other placement of the electrodes made necessary by deformed or missing extremities must be noted on the record. Selection of fleshy rather than bony sites for the electrodes will insure good contacts.

The electrodes may be any of several types provided that a low resistance can be obtained between the surface of the electrode and the skin, and so long as the metal is of low resistance and displays no condenser properties. A convenient electrode used on the extremities is one of German silver, 3.5 cm. by 5.0 cm., which is held in place by an elastic band, and which makes contact with the skin through a conducting jelly. Smaller sizes are preferred for infants.

Electrodes and their contacts with the lead wires of the recording device must be kept scrupulously clean. The entire circuit from patient to machine must be inspected frequently for defects. Unusual care to keep resistance of the skin at a minimum must be used in applying conducting jelly or paste if a single electrode on each limb is to be used for simultaneous recording of bipolar or unipolar potentials of the extremities. If such recording is to be done over an extended period of time, repeated reapplication of the jelly to eliminate drying is necessary. With any type of recording, the electrode jelly must not make contact with the lead cables.

3. Unipolar Extremity Leads (Unipolar Limb Leads). The potential of any extremity may be obtained by connecting its electrode (exploring electrode) to one input terminal of the recording device. The other terminal is connected to an indifferent electrode, preferably one with a potential as close as possible to the mean potential of the body during the cardiac cycle. Such an electrode can be constructed by connecting the right arm, the left arm, and the left leg to a central terminal, each through a fixed, noninductive resistance of 5000 or more ohms. It is imperative that the resistances between each extremity and the central terminal be equal. A galvanometric lead in which the central terminal is used as the indifferent electrode is described as unipolar.

Augmentation, whereby the resulting deflections are approximately one and one-half times as large as their true size, may be accom-
plished by severing the connection between the central terminal and the extremity being studied.

In recording the extremity potentials, either in the ordinary unipolar or augmented way, the electrocardiograph is to be so adjusted that a deflection of 1 cm. in the finished record corresponds to a potential difference of 1 millivolt. Any increase in sensitivity of the instrument made necessary by small deflections should be clearly recorded on the curve, preferably at the beginning and at the end of the lead. Connections to the galvanometer are to be made in such a way that relative positivity of the exploring electrode will cause an upright deflection in the electrocardiogram.

When made in the ordinary way the records from the right arm, the left arm, and the left leg are to be designated by the symbols $V_R$, $V_L$, and $V_F$ respectively. When the records have been augmented each of these symbols should be preceded by a lower case letter, $a$, as follows: $aV_R$, $aV_L$, $aV_F$.

4. Precordial Leads. The exploring or precordial electrode should be circular and 3 cm. or less in diameter. In children under 10 years of age the diameter should be 1.5 cm. or less. The indifferent or distant contact is to be placed on the central terminal. Leads obtained in this way are designated by the letter $V$ (for voltage) followed by a subscript depending upon the location of the exploring electrode according to the following plan: Subscript 1 shall be used for a lead from the right sternal margin at the fourth intercostal space; subscript 2 for a lead from the left sternal margin at the fourth intercostal space; subscript 4 for a lead from the fifth intercostal space where it is crossed by the midclavicular line; subscript 3 for a lead from a point midway between points 2 and 4; subscript 5 for a lead from the junction of the left anterior axillary line with the horizontal level of position 4. Subscripts 6, 7 and 8 are for leads on the same horizontal level but at the left midaxillary line (6), the left posterior axillary line (7) and the left midscapular line (8), respectively. When additional leads are made from the right side of the thorax, their location is to be indicated by arabic subscripts as for the left side, to be followed by the letter $R$ (for right). A lead from the fifth intercostal space in the right midclavicular line thus will bear the designation $V_{R_6}$. If a lead is made from the tip of the ensiform it shall be designated by a lower case e as the subscript, e.g. $V_e$.

For routine purposes leads should be made from at least three areas widely distributed over the precordium. In this regard the combination of locations 1, 3 and 5 have been found useful, though leads from the first six positions are more informative and, therefore, preferable.

If for any reason the preferred central terminal is not used and instead the right arm, the left arm, the left leg, or a point on the back is the site of the indifferent electrode, the resulting precordial lead is designated as CR, CL, CF, or CB for the respective sites followed by an arabic subscript to indicate the location of the precordial electrode as described above.

In taking unipolar precordial leads, connections to the recording device are to be made as described for the unipolar extremity leads, so that relative positivity of the exploring electrode is represented by an upward deflection in the finished record.

It will be found convenient in taking precordial leads of high voltage to adjust the electrocardiograph so that a deflection of 0.5 cm. in the finished record corresponds to a potential difference of 1 millivolt. The sensitivity should be clearly indicated on the curve by recording at its beginning and at its end the effect of introducing a potential difference of 1 millivolt into the galvanometric circuit.

If large, pendulous breasts are present, it is recommended that these be displaced upward so that as little mammary tissue as possible is between the exploring electrode and the heart.

5. Unipolar Esophageal Leads. The exploring esophageal electrode is preferably a small cylinder, approximately 3 mm. by 4 mm., made of noncorrosive metal. It is connected by insulated wire approximately 100 cm. in length to a clip or jack to which an input terminal of the galvanometer may be attached readily. Several

* By this nomenclature there is no lead $V_{R_6}$ or lead $V_{R_8}$ because the precordial stations to which they would apply are ordinarily designated as leads $V_1$ and $V_2$, respectively.
“ring electrodes” insulated from each other at distances of 2.5 to 5.0 cm. may be arranged along a small bore tube similar to a stomach tube. With this electrode, multiple leads may be made from several esophageal levels without moving the tube.

The depth of an electrode in the esophagus is measured from the anterior nares or the incisor teeth. In adults the exploring electrode is usually close to the heart at levels between 30 cm. and 55 cm. from the reference points. Placement and localization are accomplished best with the aid of a fluoroscope. However, adequate records may be obtained without a fluoroscope if the electrode is placed initially 60 cm. from the reference level. It is then withdrawn gradually in increments of 5 cm. and a record made from each level. If a multiple terminal electrode is available this stepwise procedure is easier to do. The exploring electrode will usually be close to the left atrium when it is 40 cm. from the anterior nares and close to the left ventricle when it is 50 cm. from the anterior nares. These distances are a few centimeters shorter when the incisor teeth are used as a reference level.

The central terminal is to be used as an indifferent electrode as described for other unipolar leads. Response of the electrocardiograph to the introduction of a potential difference of 1 millivolt must be adjusted to the size of the deflections to be recorded, and must be clearly shown on each lead made.

The leads obtained are designated by the symbol V followed by the upper case subscript E and an arabic number to indicate the distance of the electrode from the anterior nares or the incisor teeth, e.g., $V_{E13}$, $V_{E58}$.

C. Nomenclature

1. The symbols P, $T_p$, *QRS, T, and U are to be used to represent the deflections or groups of deflections encountered in the electrocardiogram. Criteria for the use of these symbols apply to all leads, unipolar and bipolar, normal and abnormal.

2. The P wave is normally the gradual initial deflection of any group, and may be a summit or a depression. The level or reference from which its voltage is measured is the isoelectric level (T-P or U-P interval). If it displays turning points on either side of its reference level, it is described as diphasic. If the initial turning point is above this level, it is said to be of the plus-minus (+ −) type, and if below, it is said to be of the minus-plus (− +) type.

In esophageal and intracardiac leads the P wave will usually be composed of multiple, rapid deflections not unlike the QRS group of leads from the body surface. It is recommended that the same symbols and criteria of application be used as for the initial ventricular group (see paragraph 5 below) but that the symbol for each atrial deflection be followed by the subscript P, e.g., $Q_p$, $R_p$, $S_p$, $R'_p$, $S'_p$, $R''_p$, $S''_p$. Further, the level of reference of these deflections, as for the P wave itself, is to be the isoelectric line (T-P or U-P interval).

3. The $T_p$ wave may be found in the P-R segment, that part of the trace between the end of the P wave and the beginning of QRS. It usually continues through the QRS interval. If discernible in leads from the body surface it is a shallow deflection usually below but sometimes above its level of reference, the isoelectric line. In esophageal and intracardiac leads it is often of larger amplitude and may be multiphasic. When there is atroventricular block, an S-Tp segment preceding and a low summit $U_p$ following the $T_p$ may be identified in such leads.

4. In the majority of electrocardiograms the QRS complex is superimposed on the $T_p$ deflection. For this reason the level of reference from which the voltage of QRS is measured should be at the level at which the first of the QRS components begins. The voltage of an upward QRS deflection is determined by measuring the vertical distance between the upper edge of the trace at the beginning of the QRS interval and the upper edge of the trace at the apex of the deflection. The voltage of a downward deflection is determined by measuring the vertical distance between the lower edge of the trace at the beginning of the QRS interval and the lower edge of the trace at the bottom of the deflection.

5. In order to indicate how the QRS complex
should be subdivided for the purpose of assigning symbols to its deflections, it should be borne in mind that the first deflection begins at the onset of the QRS interval when the trace first leaves the reference level. From this point the trace rises or falls to a turning point where the direction of its motion is reversed. It may pass through a second and third turning point or even more, causing notches, before crossing to the opposite side of the reference level.* At this crossing the first deflection ends and the second begins. The second deflection, necessarily opposite in direction to the first, must display one turning point and may display many; it does not end until the trace crosses the reference level for the second time. There may be a deflection which begins at the second crossing and ends at the S-T junction. No part of the QRS complex which does not cross the reference level should be considered a separate deflection. If the S-T junction is displaced in a direction opposite to the turning point of the last deflection of QRS, that portion of QRS which lies between this point and the S-T junction should be considered a part of the last deflection.

The earliest QRS deflection which lies above the reference level should be labeled R. Any downward deflection which precedes R should be labeled Q. The first of any downward deflection which may follow R should be labeled S. The first of any upward deflections which may follow S should be labeled R', and the first of any downward deflections which may follow R' should be labeled S'. If it is necessary to label still later deflections of the QRS group, the symbols R'', S'', and so on, should be used in accordance with the same principles. When R is absent and the QRS complex consists of a single downward deflection, this deflection should be labeled QS. In statistical studies QS, Q, and S deflections should be considered separately.

* When the trace is descending it crosses the reference level at the instant when its lowest margin reaches a position below that which it occupied at the beginning of the QRS interval. When the trace is ascending it crosses the reference level at the instant when its upper margin reaches a position above that which it occupied at the beginning of the QRS interval.

A deflection is "notched" when it displays more than one turning point on the same side of the reference level. A deflection is "slurred" when it displays a distinct and local thickening on either limb, or at its apex, owing to a sudden and pronounced change in the slope of the curve.

When the form of the QRS complex varies from moment to moment because of the effect of respiratory movements on the position of the heart or for some similar reason, the classification of this complex should be determined by the variety of complex which is most abundant, or, if no type is numerically predominant, by the outline of the complexes which are of intermediate form. Small QRS complexes (largest deflection less than 0.5 millivolt) which display more than three components or multiple slurring and notching should be classed as "small and bizarre" or "vibratory."

In unipolar leads the "intrinsicoid (or RS) deflection" ordinarily begins at the peak of the R wave and ends with the nadir of the S wave. It is usually the steepest and longest downstroke of QRS. In certain precordial leads there may be two R waves (R and R') and one or two S waves (S and S'). Under these circumstances the longer downstroke is ordinarily regarded as the characteristic one in the lead, although occasionally a shorter but later and more gradually sloping intrinsicoid deflection may have considerable diagnostic significance.

6. The term "S-T junction" or "J" (RS-T junction) should be used to indicate the point or shoulder which marks the end of the QRS complex, the point where the steep slopes of the QRS deflections are more or less abruptly replaced by the more gradual slopes which precede or comprise the first limb of the T wave. In many electrocardiograms the S-T junction is followed by a nearly horizontal or gently sloping segment which lies on, above or below the reference level and ends with the onset of a much steeper slope that rises or falls to the apex of T. The term S-T segment is used for this part of the ventricular complex when it exists, even though electrophysiologically it is the earliest part of the T deflection. When there is no point between the S-T junction and the apex of T at which a sharp change in the
slope of the trace occurs, this part of the ventricular complex should be called the “first limb of the T wave.” When the term “S-T segment” is used without reference to some particular electrocardiogram or to some particular class of electrocardiograms, it should be understood to refer merely to that part of the ventricular complex which immediately follows the S-T junction.

The reference level for the measurement of the displacement of the S-T junction (or J) should be the P-R segment at the beginning of QRS. The level of reference for the measurement of the S-T segment, the T wave and the U wave should be the isoelectric level (T-P or U-P interval) when this can be determined; otherwise it should be the level of the trace at the beginning of the QRS interval.

7. The term “diphasic T waves” should be applied to those final ventricular deflections which present two distinct turning points, one on each side of the level of reference, as described for the P waves (see paragraph 2 above).

8. The P-R interval is measured from the beginning of the P wave to the beginning of QRS whether this be represented by a Q wave or an R wave. This interval varies from lead to lead in the same subject. It is recommended that the longest P-R interval found in the bipolar or unipolar extremity leads be regarded as the P-R interval. The longest P-R interval is not necessarily the correct one, but because it does not usually differ from the latter by more than 0.01 second in either direction and because it is easy to measure it is preferred. The most exact approximation to the true P-R interval is obtained by measuring the longest time between the beginning of P and the end of QRS in the six bipolar and unipolar extremity leads, and subtracting from this the longest QRS interval found in these leads. With increased usage of simultaneous recording, significant discrepancies between the “longest P-R interval” and the true P-R interval should be easy to detect.

9. The QRS interval is measured from the beginning (Q or R) to the end of the QRS group of deflections. The longest QRS interval found in the bipolar or unipolar extremity leads is regarded as most nearly correct.

10. The Q-T interval is measured from the beginning of QRS to the end of the T wave. The longest interval found in any lead from the surface of the body is regarded as most nearly correct. Since this interval varies with rate, a correction for this variable must be made in comparative studies.

11. The Q-U interval is measured from the beginning of QRS to the end of U wave. The longest interval found in any lead from the surface of the body is regarded as most nearly correct. Since this interval varies with rate, a correction for this variable must be made in comparative studies.

**Vectorcardiographic Leads**

**A. Instruments**

Minimal requirements for acceptable vectorcardiographs employing cathode-ray tubes have not yet been established.

**B. Technics**

In its present state of development there can be no agreement on the technic to be used in recording vectorcardiograms. Studies of comparative differences are available and convincing, but studies of the comparative value of the various reference systems in use are largely nonexistent at this time. Despite this keenly felt gap in our knowledge, some general agreement on procedure acceptable to physicians and investigators alike will conceivably further rather than retard progress in the field of vectorcardiography just as a standardization of leads promoted clinical progress in precordial electrocardiography a decade and a half ago.

1. **Designation of Axes and Planes.** The objective of using any system of recording vectorcardiograms is to obtain the record in one plane, or to be able to synthesize in a variety of ways its spatial configuration from recordings made in two or more planes. Since all reference systems in use are three-dimensional, a standard designation for the three axes and three planes involved would seem desirable. It is to be noted that such a standardization of designa-
tion in no way fixes the method by which the true record in these planes is obtained. The need for uniformity is accented by the fact that already two different nomenclatures have appeared in the literature.

It is recommended that the three axes of the body—transverse, longitudinal, and sagittal—be designated by the symbols $x$, $y$, and $z$ respectively. It is also recommended that the three planes defined by these rectilinear co-

The conventions to be followed are relatively simple and logical if the source of the cardiac electromotive force is regarded as being a single point. Initially the cardiac vector can only have a direction in three-dimensional space away from this point of zero reference. Under these circumstances the point in question must always be initially electronegative with respect to any other point in the body.

The common method of recording the vector-

 ordinates—the transverse, the frontal, and the sagittal—be designated by the symbols $xz$, $xy$, and $yz$ respectively.

2. Polarity of Leads. A good deal of misunderstanding exists with regard to the polarity of the leads to be used in any vectorcardiographic reference system. This arises largely from confusion of the direction of motion of the cathode ray when the standardizing voltage is applied with the direction of this motion which results when a voltage obtained from the body is applied.

The cardiogram to date is by means of the cathode-ray tube. This tube has four deflection plates, two vertical and two horizontal. When the plates are free of potential the electron beam is in the center of these equidistant and circumferential plates. The “spot” which the beam makes on the face of the tube may be regarded as analogous to the theoretic point source of cardiac potential somewhere in the thorax. To insure correct connections of surface leads in any reference system to the deflection plates it is necessary merely to imagine the screen of the...
tube as parallel to the plane of the body (frontal \( xy \), sagittal \( yz \), or transverse \( xz \)) being studied, with the observer facing it. The four plates, in the case of the frontal plane, can be divided into superior and inferior, right and left (the right on the observer’s left, and the left on the observer’s right). In the case of the sagittal plane they are superior and inferior, anterior and posterior, and in the case of the transverse plane they are anterior and posterior, right and left (fig. 1). In any system of bipolar leads, pairs of electrodes on the body are attached to pairs of the cathode-ray plates bearing the same relative positions to the respective point sources of potential: the heart in the body, the “spot” on the cathode-ray screen. In unipolar leads the exploring electrode is attached to the plate corresponding to the location of the exploring electrode on the body. For example if lead \( aV_r \) is regarded as giving the \( y \) component of the vectorcardiogram, the exploring electrode is attached to the lower plate and the central terminal of Wilson, Macleod and Barker to the upper plate in either the frontal or sagittal displays. If the body is viewed from above, and a point on the back is regarded as yielding the \( z \) component, the exploring electrode is attached to the posterior plate; but if a point on the front of the chest is used for this component, the exploring electrode is attached to the corresponding anterior plate.

3. Selection of Views. In figure 1 it will be seen that there are two views for the transverse and sagittal displays (above or below, left or right). There is also a rear view of the frontal record obtained simply by reversing the connections to the \( x \)-axis plates. This view is rarely if ever used in vectorcardiography. With regard to transverse and sagittal views, the alternatives in each instance seem to have been used with almost equal frequency by various investigators in the field. Nevertheless, clinical usage would be augmented if only one of the two alternatives for each display were used routinely. Toward this end it is recommended that the preferred views of the spatial vectorcardiogram be from the front, from above, and from the left.

4. Polarity of Standardizing Voltages. If the above recommendations on polarity are followed in recording leads, it makes no difference which polarity is used for the standardizing voltages placed across the plates. For uniformity, however, it is suggested that in the individual axes the polarity be arranged so that the direction of planar displacement of the electronic beam in response to the impressed force will be respectively to the left, downward, and backward.

C. Nomenclature

As in the conventional electrocardiogram it is possible to identify portions of the vectorcardiographic trace ascribable to four different electrical processes. These are depolarization and repolarization of the atria and of the ventricles. By the usual methods of recording, the tracings of these processes overlap on the face of the cathode-ray tube. However it is possible to separate them one from the other by electronic and photographic selection. The exception is that part of the trace caused by repolarization of atrial muscle, the terminal portion of which is normally obscured by the simultaneous occurrence of ventricular depolarization. However, even this part of the trace may be distinctive if there is prolonged or blocked atrioventricular conduction.

It is recommended that the four components of the vectorcardiogram be designated as “forms” or “loops” and that the letters \( P, T_r, QRS, \) and \( T \), be used to describe the four forms ascribable to the same electrical processes which account for the similarly designated deflections in the conventional electrocardiogram. If an after-potential form can be identified, it is recommended that this be called the \( U \) form.

Since an abbreviation or symbol for the word “vectorcardiogram” will clearly be useful, it is suggested that this be VCG.

The Committee discussed other aspects of nomenclature in vectorcardiography, but opinions varied so widely it was concluded not to make further recommendations at this time.

REFERENCES


Recommendations for Standardization of Electrocardiographic and Vectorcardiographic Leads
FRANK N. WILSON, CHARLES E. KOSSMANN, GEORGE E. BURCH, EMANUEL GOLDBERGER, ASHTON GRAYBIEL, HANS H. HECHT, FRANKLIN D. JOHNSTON, EUGENE LEPESCHKIN and GORDON B. MYERS

Circulation. 1954;10:564-573
doi: 10.1161/01.CIR.10.4.564

The online version of this article, along with updated information and services, is located on the World Wide Web at:
http://circ.ahajournals.org/content/10/4/564.citation

Permissions: Requests for permissions to reproduce figures, tables, or portions of articles originally published in Circulation can be obtained via RightsLink, a service of the Copyright Clearance Center, not the Editorial Office. Once the online version of the published article for which permission is being requested is located, click Request Permissions in the middle column of the Web page under Services. Further information about this process is available in the Permissions and Rights Question and Answer document.

Reprints: Information about reprints can be found online at:
http://www.lww.com/reprints

Subscriptions: Information about subscribing to Circulation is online at:
http://circ.ahajournals.org//subscriptions/