MEASUREMENT OF HEIGHT OF ELECTROCARDIOGRAM WAVES

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(Received August 20, 1955. Presented by Prof. V. N. Chernigovsky, Member Acad. Med. Sci. USSR)

In recent times, not only the form of the waves of electrocardiogram (ECG) tracings, but also their height, i.e., the voltage, are considered in reading diagnostic or experimental ECG records.

The height of the ECG waves is usually measured in mm, and it also shows the scale of the recording, and the value of a millivolt on the scale (the size of a millivolt expressed in linear units (mm) of the height of a wave).

It is often very difficult to compare the dimensions of the waves, i.e., their voltage, of electrocardiograms taken at different times and at different amplifications, i.e., with different scales of millivolt dimensions. It is then necessary to express the wave dimensions in millivolts, which involves the laborious measurement of wave heights, followed by conversion of linear units to millivolts; all this is most time-consuming, and is for this reason seldom carried out in practice.

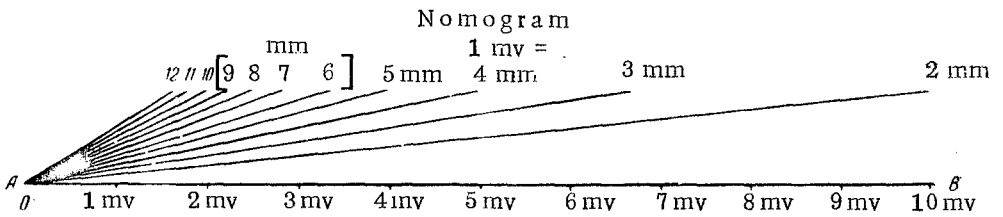

Fig. 1.

Fig. 2.

We here present a table and a nomogram, designed to facilitate and expedite the conversion operation. The Table gives the most commonly encountered dimensions of ECG waves (from 0.5 to 20 mm), expressed as millivolts at different scales of recording, i.e., with equivalent heights of a millivolt of from 2 to 12 mm.

The first vertical column of the Table gives the scale, i.e., the magnitude of a millivolt expressed in mm, while the top horizontal row gives the height of the ECG waves in mm. The height of the waves in millivolts are given by the figures at the intersection of the appropriate horizontal rows and vertical columns.

Thus, for example, the height of an R wave of an ECG is found, using one of the leads, to be 11 mm with a millivolt scale of 7 mm. The value given for 11 mm in the vertical column and 7 mm in the horizontal row is 1.57 millivolts, which is the potential of the given wave.

A nomogram is shown in Figure 1. The base AB of the nomogram gives the linear representations of the height of the ECG waves in millivolts (mv), the scale chosen being 200 mm per 10 mv, whence it follows that 20 mm corresponds with 1 mv, and 1 mm with 0.05 mv. According to the precision required, the scale may be enlarged or made smaller.

TABLE

Table for Conversion into Millivolts of the Height in mm of ECG Waves.

Millivolt scale (mm)	Height of wave in mm																							
	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0	16.0	17.0	18.0	19.0	20.0
2	0.25	0.5	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50	3.00	3.50	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00	8.50	9.00	9.50	10.00
3	0.17	0.33	0.50	0.67	0.83	1.00	1.17	1.33	1.50	1.67	2.00	2.33	2.66	3.00	3.33	3.67	4.00	4.33	4.67	5.00	5.33	5.67	6.00	6.33	6.67
4	0.12	0.25	0.37	0.50	0.62	0.75	0.87	1.00	1.12	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00
5	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	1.20	1.40	1.60	1.80	2.00	2.20	2.40	2.60	2.80	3.00	3.20	3.40	3.60	3.80	4.00
6	0.08	0.17	0.25	0.33	0.41	0.50	0.58	0.67	0.75	0.83	1.00	1.16	1.33	1.50	1.67	1.83	2.00	2.17	2.33	2.50	2.67	2.83	3.00	3.17	3.33
7	0.07	0.17	0.21	0.28	0.36	0.43	0.50	0.57	0.64	0.71	0.85	1.00	1.14	1.28	1.43	1.57	1.71	1.86	2.00	2.14	2.28	2.43	2.57	2.71	2.86
8	0.06	0.12	0.19	0.25	0.31	0.37	0.43	0.50	0.56	0.62	0.75	0.88	1.00	1.12	1.25	1.37	1.50	1.62	1.75	1.87	2.00	2.12	2.25	2.37	2.50
9	0.05	0.11	0.17	0.22	0.28	0.33	0.39	0.44	0.50	0.56	0.67	0.78	0.89	1.00	1.11	1.22	1.33	1.44	1.55	1.67	1.78	1.89	2.00	2.11	2.22
10	0.05	0.10	0.15	0.20	0.25	0.30	0.35	0.40	0.45	0.50	0.60	0.70	0.80	0.90	1.00	1.10	1.20	1.30	1.40	1.50	1.60	1.70	1.80	1.90	2.00
11	0.04	0.09	0.14	0.18	0.23	0.27	0.31	0.36	0.41	0.45	0.54	0.64	0.73	0.82	0.91	1.00	1.09	1.18	1.27	1.36	1.45	1.54	1.64	1.73	1.82
12	0.04	0.08	0.12	0.17	0.21	0.25	0.29	0.33	0.37	0.41	0.50	0.58	0.67	0.75	0.83	0.91	1.00	1.08	1.17	1.25	1.33	1.42	1.50	1.58	1.67

At point A of Figure 1 we draw a number of lines at different angles to the base-line AB of the nomogram, each for a different linear magnitude of a millivolt, from 2 to 12 mm.

To know the potential of an ECG wave we must first know the equivalent height of a millivolt, in mm (i.e., the scale of a millivolt). The linear height of a wave, measured with the aid of a pair of dividers, is marked on one of the sloping lines of the same millivolt equivalent, and a perpendicular is drawn from this point to the base-line; the point of intersection will give the required result. For example, with an equivalent height of a millivolt of 11 mm (Figure 2), the linear height of a wave (distance between the legs of a pair of dividers) is equal in length to a perpendicular erected on the line AB at a distance of 16 mm from A. On the given scale, the potential of the given wave will be 0.8 mv.

Geometrical basis of the nomogram

The nomogram is constructed on the principle of similar triangles. Taking a maximum ECG wave height of 20 mm we determine its value in millivolts, for a millivolt equivalent of 2 mm, 3 mm, etc., up to 12 mm, either experimentally or from the Table, and the resulting values are marked off on the base-line AB of the nomogram. From these points we erect perpendiculars 20 mm in height, and join the tops of these perpendiculars to point A. For example, a wave 20 mm high, at a millivolt scale of 11 mm, corresponds with a value of 1.82 mv. At the given scale, this value will be represented on AB by the point D, at a distance of 36 mm from A (see Figure 2). From this point we erect a perpendicular DC, equal to the maximum height of the wave, viz., 20 mm. The top of this perpendicular is joined to A.

The heights of all the perpendiculars to the base AB (wave heights) of the triangle formed are proportional to the corresponding lengths of the bases of the triangles, since the triangles so constructed are similar ones. If the perpendicular DC (wave height in mm) corresponds to the section AD (expression of wave potential in mv), then all the sections perpendicular to AD will correspond with sections from point A to the point of intersection of the perpendiculars with AD, i.e., with their value in mv.

It is in practice more convenient to draw the nomogram on sheet metal or celluloid, with a movable ruler fixed at point A, connecting it with any desired millivolt equivalent scale point, which saves the trouble of drawing the sloping lines for each millivolt equivalent scale.