# A TECHNIQUE FOR MEASURING THE OXIDATION-REDUCTION POTENTIAL OF SKIN AND OTHER SURFACES*

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(Received for publication February 28, 1940)

## INTRODUCTION

In 1925, Alvarez, Freedlander and Clark developed an electrode to study differences of potential in various parts of the human body (1). Applying this electrode to the skin, they found such marked variations in different subjects and on different days that the workers did not attempt an explanation of the erratic results they obtained. In 1931, Purdy, Johnson and Sheard used this electrode to take readings of the potential differences of skin surfaces and studied their relation to basic metabolic rates (2). They found a hyperbolic relationship between the readings and the B.M.R.

Several investigators have utilized dyes in measuring the oxidation-reduction potentials of the skin. Leczczynski and Falik in 1937 measured the reduction time of 0.02 per cent aqueous methylene blue solution in contact with the skin (3). Radaeli used several different dyes in studies of changes in their reduction times in normal and pathological skins (4). Torrance has studied oxidation-reduction potentials of inflammatory lesions and of the normal skin of shaved guinea pigs, using a series of dyes in both the oxidized and reduced forms (5, 6).

## APPARATUS

In our studies we have been measuring the Eh and pH of diseased and normal skins; results of these studies will be published

* Material used by Rita M. Kelley in thesis for Degree of Master of Public Health (Massachusetts Institute of Technology) done under the direction of John W. Williams.

later. We have used the electrometric technique, employing the following electrodes in conjunction with a Beckman pH meter:

1. Calomel reference electrode, #1170, which is used in conjunction with each of those below.

2. Glass electrode for pH readings. This is a standard glass electrode, #1190.

3. Platinum electrode for Eh readings. This electrode was specially made for the purpose of taking readings on a flat area like the skin surface. The contacting surface of the electrode

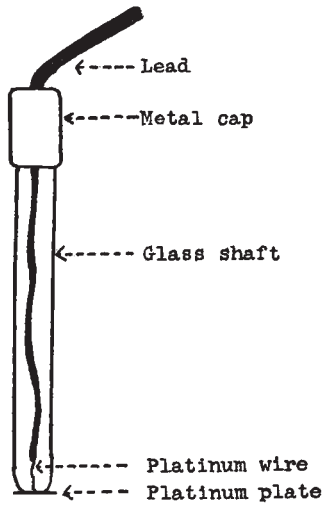


FIG. 1. DIAGRAM OF PLATINUM ELECTRODE USED IN TESTS

consists of one square centimeter of platinum with rounded corners, attached to the platinum wire which forms the usual point of contact in this type of electrode. The glass shaft of the electrode is fused to the upper surface of the platinum to hold it firmly in place and to make an air-tight connection (see fig. 1). This electrode has been standardized against a quinhydrone system and against other platinum electrodes of the usual type. It provides an excellent contact with skin surfaces.

These electrodes are used with a Beckman pH meter, laboratory model G, with the temperature dial set at 30°, the approximate skin temperature.

The electrodes are kept in a holder designed to keep the electrodes at a constant distance (2 cm.) apart during all experiments. This holder may be raised or lowered as a unit; each electrode may be moved up or down independently as well, to fit the circumstances of the test. Set up in this way, the apparatus is most readily usable for readings on the hands and arms, but it may easily be adapted for use on the face and other body areas, such as throat and tongue.

## TECHNIQUE OF MEASUREMENTS

The skin surface to be measured is thoroughly washed with ether to remove dirt and perspiration and the area is placed on the stand beneath the electrodes. The electrode holder is then lowered until the two electrodes being used (i.e., calomel and glass or platinum) are resting on the surface to be measured, at a uniform distance of 2 cm. apart. With a little practice, the pressure of the electrodes on the skin may be regulated so that it is essentially the same in all tests. Too much pressure is to be avoided, the most desirable conditions being a light but definite contact between the electrodes and the skin surface. Figure 2 shows their position during a reading on the forearm. After the electrodes are in place, the points of their contacts with the skin are moistened with a few drops of Ringer's solution, which has been found to be the most reliable solution of several tested for this type of work. Readings become stabilized after a few seconds and may be read directly. While the Eh reading is being taken, the glass electrode is swung out of position. To read pH, the platinum electrode holder is moved and the glass electrode substituted. The holder protects the electrodes from undue handling, sudden jarring, etc. The electrodes may be kept in the holder when they are not in use, care being taken to keep the collar of the calomel electrode in water to prevent its drying out. The whole stand fits into a microscope case, which makes it readily portable.

Several hundred readings have been taken using this technique, which has proved to be a simple and reliable means of measuring the Eh and pH of skin surfaces. The electrodes are wiped with alcohol between patients.

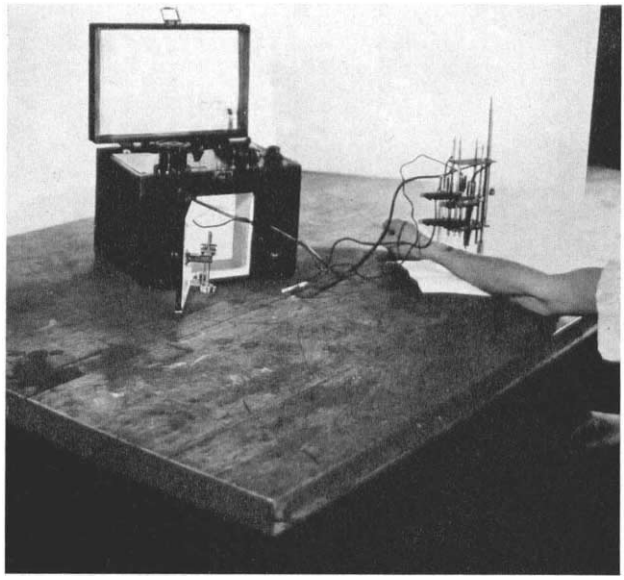

FIG. 2. APPARATUS DURING READINGS ON SKIN SURFACE OF ARM

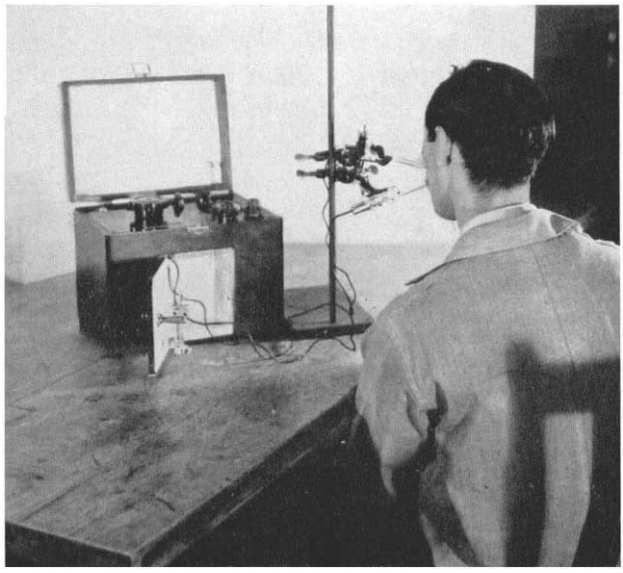

FIG. 3. USE OF ELECTRODES FOR READINGS ON FACE

Figure 3 shows one way in which the electrodes may be used for face readings. A second way is to keep the electrodes in the holder and have the patient rest his head on a pillow on the table beneath the electrodes.

## OTHER POSSIBLE APPLICATIONS OF THE TECHNIQUE

As described here, the apparatus is applicable most directly to skin surfaces. The authors believe, however, that electrodes might readily be designed for use on mucous membranes in the nose and throat, and even in the bladder and gastro-intestinal tract. Differences in readings obtained on peripheral areas of normal and erupting skin on the same person lead us to believe that similar significant variations might exist between normal and abnormal internal surfaces.

We wish to express our thanks to Prof. J. W. Horton and Mr. Joseph Gotimer for their assistance in designing and making our electrode holder, and to Mr. Henry Rugo for taking the pictures included in this paper.

## REFERENCES

(1) Alvarez, W. C., Freedlander, B. L., and Clark, L. B.: An electrode for measurements of skin potential. J. Lab. & Clin. Med., **11**: 83, 1925.

(2) Purdy, C., Johnson, A. F., and Sheard, C.: The relationship between electrical differences of potential in the skin and normal basal metabolism. Science, **73**: 46, 1931.

(3) Leszczynski, R., and Falik, E.: Reduction oxidation power of skin. Arch. Dermatol., Syphilis, **176**: 120, 1937.

(4) Radaeli, G.: The oxidation-reduction potential and the reducing process in the living skin. Archiv. fur Derm. & Syph., **178**: 253, 1938–39.

(5) Torrance, C.: Oxidation-reduction potentials and a method of determining them in skin. J. Bact., **35**: 339, 1938.

(6) Torrance, C.: Oxidation-reduction potentials of inflammatory lesions of the skin. Proc. Soc. Exper., Biol. & Med., **45**: 741, 1940.