ELECTROLYTIC PRODUCTS OF DENTAL MEDICINES.

By Weston A. Price, D.D.S., Cleveland, O. There has been a demand from the profession and a request from Dr. Bethel for some data as to the actual ions and their direction of movement, produced by passing an electric current through various dental medicines. The discussions upon the theoretical phases of the question have, on account of the breadth of that subject, not gone into a discussion of the practical application of the known laws to the uses of the common medicaments.

In passing the electric current through any medicine capable of conducting the current, there will be a movement of a part of some of the molecules in each direction. For example, in passing a current through a solution of sodium chlorid, some of the molecules will divide, the sodium ion going to the negative pole and the chlorin ion going to the positive pole. If platinum electrodes be used, the amount of sodium liberated at the negative pole will be equal to the chlorin liberated at the positive pole. And each, in any solution, will be an exact expression of the amount of current that has passed. These may react upon the electrode or upon the solution about the electrodes, as would happen with the chlorin in this case should we use copper or silver, or in fact almost any metal except platinum or iridium. Or as occurs with the sodium in this case, which reacts with the water, forming sodium hydrate, $NaOH$, with the liberation of hydrogen. It is, in fact, very seldom that the ions themselves are liberated; they usually react with the electrode or with the fluid, with the liberation of a gas or a metal. All processes of electroplating are a simple electrolysis.

Space will not permit of any suggestions as to what electrodes or reagents would be indicated in the treatment of the various pathological conditions, as pyorrhea alveolaris and bleaching teeth. We will restrict ourselves to the manner in which the molecules will divide and direction these parts will move in, giving in some cases the rapidity of migration. This latter quality is expressed by stating in centimeters the distance the ion travels in one second under a current of a potential fall of one volt per centimeter of solution, temperature at 18° centigrade. For convenience the one-hundred-thousandth of a centimeter is used instead of decimals; thus hydrogen travels 0.0032 centimeters per second, which is usually written 320, meaning 320 one-hundred-thousandths. This will be the meaning of these terms throughout this paper.

The more dilute a solution the greater per cent of the molecules will be ready to take part in the carrying of the current up to a certain point of dilution, and this point is known as the point of complete dissociation. This point varies greatly with different substances, but with sodium chlorid is at about one in one thousand, at which concentration approximately all the sodium and all the chlorin would be taking part in the carrying of the current. This matter of concentration or per cent of dissociation will not enter materially into the results of our practical work except at the extremes, and we need not consider it ordinarily. The reason for this is very simple, since in any solution capable of carrying the current there are always lots of free ions. When any compound substance, capable of conduction, is held in solution it does not maintain its molecular form, but some of the molecules, or all at sufficient dilution, will divide into two or more parts, called ions, usually two, but sometimes three or four or more, each carrying an electric charge, some positive and some negative, but always an equal amount of the two kinds of electricity. This takes place without the passage of an electric current, and, indeed, no solution will conduct a current that does not contain free ions, for it can only do so by their movement and giving up their electric charges to their opposite electrodes. When a current passes through any solution the positively charged ions move toward the negative pole and the negatively charged toward the positive pole. By no other means can a current pass through any liquid, except a metal. Very many substances do not dissociate in solution, as sugar. Some others do so, but to a very slight extent. The former are perfect non-conductors or insulators to the current, while the latter conduct but slightly. These latter include many of our dental medicines.

In electrolysing hydrochloric acid, HCl. in water, H will go to the negative pole and Cl. to the positive pole, where it will react with the electrode unless it be a very noble metal, and even then to a slight extent. If the current have a potential gradient of one volt per centimeter and the temperature about 18° centigrade, the H ions will travel with a velocity of 320 one-hundred-thousandths of a centimeter per second, or approximately three inches in an hour, and the Cl. will travel to the positive pole with a velocity of 69, always carrying equal electric charges. With sulphuric acid, H_2SO_4, two H ions will go to the negative pole and SO_4 to the positive pole, where it will react with the electrode or with the water, according to the following equation: $2SO_4 + H_2O = 2H_2SO_4 + O_2$. If a copper electrode were used it would unite with it, forming copper sulphate $CuSO_4$, which would immediately dissociate and begin to assist in carrying the current, the copper forming a new ion and going to the negative pole and SO_4 to the positive pole.—With nitric acid, HNO_3, the H will go to the negative pole and NO_3 to the positive pole, with a velocity of 64.—With silver nitrate, Ag NO_3, Ag will go to the negative pole with a velocity of 57 and NO_3 to the positive pole.—With potassium iodid KI, K will go to the negative pole with a velocity of 66, and I to the positive with a velocity of 69.—With sodium hydrat, NaOH, Na will go the negative pole with a velocity of 45 and OH to the positive pole with a velocity of 182.—With lithium iodid, LiI, Li will go to the negative pole with a velocity of .36 and I to the positive with a velocity of 69.—With ammonium hydrat, NH_4OH, NH_4 will go to the negative pole with a velocity of 66 and OH to the positive pole with a velocity of 182.—With hydrochlorat of cocain, $C_{10}H_{27}NO_4HCl$, all investigations so far indicate that $C_{10}H_{27}NO_4H$ goes to the negative pole with a velocity of about 7 and Cl. to the positive with a velocity of 69.

These determinations on cocain were completed too late to appear in their proper connection in a recent paper published in May *Items*. We are indebted to Professor Morley, of the Western Reserve University, for these determinations on cocain hydrochlorat, which mean a tremendous amount of tedious experimentation. This means that the negative ion of cocain hydrochlorat will migrate about one inch into a tooth in one hour at a potential gradient of 25 volts.

I would like to call attention to the behavior of the Cl. ion which goes to the positive pole. If that electrode be anything but the noblest metals, as platinum or iridium, it will react with it, forming the chlorid It will even do this to some extent with gold, not enough to positively exclude it as an electrode in cataphoresis, though it is not nearly so good as platinum, with which the chlorin reacts, but very slightly. Copper or silver, or German silver, or any metals of their class, would almost produce a failure if used for the positive pole in cataphoresis, because they would form a chlorid with the Cl. and this would immediately dissociate, the metal forming the positive ion and go to the negative pole and the Cl. to the positive again. Thus in a short time this new compound would be carrying the current instead of the cocain hydrochlorat.

Almost any solution we may get hold of, unless prepared with the utmost care, will contain enough impurities to prevent us from determining by its conductivity whether it is an electrolyte or not, as for example, ordinary water, which is a splendid conductor, while absolutely pure water is almost as good an insulator as gutta-percha. Such purity cannot be had, however, by ordinary means. For this reason we should expect the best results in cataphoresis, and in my experience we do, from freshly prepared solutions of as pure as possible a quality of cocain salt in distilled water, the purer the better, and never should we use anything but a very noble metal for the positive electrode, preferably platinum.

Under the head of this paper should properly come a discussion of the various agents used for bleaching teeth, in connection with the electric current. These would take too much space and may be made the subject of a special article. I will say, however, neither sodium peroxid or hydrogen peroxid, or even chlorid of lime, are found in qualitative tests of electrolysis to behave as has been suggested.

It has been quite generally taught by some writers and quite generally believed, that in electrolysis, certain medicines move unchanged towards the negative pole, and certain others move toward the positive pole. THIS IS NOT SO, and every effort should be made to correct this terribly misleading impression. A part of the molecular contents of some of the molecules of that medicine go in each direction and electro-equivalent parts in each direction. Electrolysis must not be confounded with osmosis, which is the movement of a substance held in solution as it diffuses to equalize the concentration.—*Ohio Dental Journal, June, 1898.*

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