ROCKWELL
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Present State of Electro-Therapeutics.

Electricity in its relations to practical medicine has for many years been little more than a dead letter in the therapeutical alphabet. Recently, however, a very decided and remarkable interest seems to have been revived, both here and in Europe, in this department of our profession; and it is to be hoped that this fascinating field of research will not again be given over to the tender mercies of charlatanical greed.

In the brief time allotted to me it would be vain to attempt a comprehensive and at the same time a minute exposition of even a single division of my subject. I propose therefore to offer a few words, first, on the physics and physiology of electricity; second, to give a general summary of the different methods of its application; third, to estimate, if possible, the measure of benefit to be derived in the treatment of disease by its judicious and scientific use.

The terminology of electro-therapeutics has been and is in such a vague and uncertain condition that intelligent conversation with one who is not specially versed in the subject is well-nigh impossible. Let me then at the outset, at the risk of being thought to dwell unnecessarily on the simple

* Read by invitation before the last session of the New York State Medical Society.

facts of electro-physics with which we are all supposed to be familiar, say that electricity is manifested in three forms; viz., magnetism, static electricity, and current electricity.

Magnetism. The magnet need not detain us. As a therapeutic agent it is of little or no importance, and the beneficial results supposed to have been obtained by its use in certain neuralgias depend doubtless on mental excitation.

Static electricity. Static electricity, as is well known, is generated by friction, and denotes the electrical condition of bodies in which electricity remains insulated or stationary. By passing a number of electrical discharges through the air Priestly succeeded in forming an acid out of oxygen and nitrogen; thus demonstrating the presence of a chemical effect. It was, however, proved conclusively by Faraday, whose researches in this department were most elaborate, that as the quantity of electricity generated by any frictional machine is exceedingly, almost infinitesimally, small, so static electricity possesses very feeble chemical or electrolytic effects. When applied to the head it has power to produce a distinct physiological action on the brain only when its tension is so great as to endanger health and even life. Of the nerves of special sense the optic and gustatory alone are sensibly affected by it. The peculiar smell that is perceived when an electrical machine is in operation near by, and which was supposed to have been due to an excited state of the olfactory nerve, we now understand to be due to the development of ozone. Static electricity then deserves no further consideration in this paper. Its want of decided chemical effect renders it of little use in electro-surgery, while most of the indications for its use in medicine are met more effectually by the faradic current.

Current (dynamic) electricity. Under the term current electricity must be included both galvanic and faradic electricity. Galvanic electricity is generated by the action of gases or fluids or metals, or by the contact of two dissimilar conductors. The quantity of galvanism developed by the action of fluids

upon metals depends, first, upon the extent of surface acted on by the fluids; and second, on the strength of the fluids. Thus plates of zinc and copper, each two inches square, immersed in a solution of sulphate of copper, generate but half the quantity of electricity produced by the action of the same solution on plates presenting twice the extent of surface. What we term intensity or tension depends on the number of cells that are brought into the circuit. The electric tension of every compound battery is increased with every cell that is added; but it must be remembered that the quantity of electricity from a battery containing any number of cells is no greater than the amount generated by the first cell of the series. To obtain therefore a sufficient quantity of galvanism to raise a platinum wire to a white heat, for the purposes of cauterization and amputation, we require but a few large elements, say four or five. This gives a sufficient volume of current to overcome the great resistance offered by the platinum without developing any marked electrolytic effects. The galvanic current affects powerfully by reflex as well as by direct action. Applied to any portion of the head or face so as to affect the retina, directly or indirectly, through any of the nerve branches, a flash of light is at once perceived, and with a little care the vital function of each nerve of special sense can be excited with no unpleasant results. It has power to stimulate directly the brain, spinal cord, and great sympathetic, and is thus invaluable in the treatment of many forms of central disease.

The faradic current is the current of induction. For its development we need simply a single galvanic cell, to which is attached a helix consisting of wires of varying thickness and length. For a description of the mechanism of this helix and its rheotome I must refer to works on physics. The faradic current works very slightly by reflex action, and has but little power to influence directly either the brain or spinal cord. It undoubtedly reaches the great sympathetic;

but it is impossible to localize its effects in any of the ganglia, or to call their special function into action when the nerve is in a measure paralyzed. It does not in any way excite the nerves of special sense unless they are in a state of abnormal irritability, or without the current is of such tension as to endanger the integrity of their normal function.

The impression very generally seems to prevail that there are many kinds of electricity; and this impression is strengthened from the fact that in most of the works on electro-therapeutics, and in almost every published article on the subject, we find adopted a crude and indefinite nomenclature. On the one hand, we hear and read of the primary, the galvanic, the constant, and the continuous currents; on the other, of the secondary, the faradic, the induced, and the interrupted currents. Now we can avoid all this confusion if we recollect that aside from magnetism and static electricity but two forms are manifest, viz., galvanic and faradic electricity. With the first of these the terms primary, constant, and continuous are synonymous; with the second the terms secondary, induced, and interrupted exactly accord. The expressions direct and indirect have been a stone of stumbling to many who have supposed them to refer to the two currents. They merely designate the direction of either current; direct signifying from the center toward the periphery; indirect, from the periphery toward the center.

Speaking of the two currents, the question is frequently asked by both physician and patient, In what do they differ? Is the galvanic stronger than the faradic? These questions are difficult to answer, in a word. It may be said that the galvanic possesses powerful electrolytic properties, is capable of penetrating to the brain and spinal cord, calls into action the vital functions of the nerves of special sense, and affects strongly by reflex action; but under certain conditions the faradic current will do all this. A galvanic current of feeble tension produces slight contraction, and may be hardly felt

by the patient; while a faradic current of relative strength may cause pain, and throw the muscle into violent contraction. To the patient the faradic current seems much the more powerful of the two, but the superior potency of the other is readily manifest in the dizziness produced, the flashes of light following excitation of the retina and other resulting phenomena. What then is the essential distinction in the effects of these currents on the body? Experiment and experience lead us to believe it to be mainly of degree rather than a difference in kind, although practically it amounts to the latter. When we come to study the differential indications for the use of the two currents, it is evident that a thorough knowledge of the special physical and physiological advantages of the one over the other will be of service. The advantages of the galvanic over the faradic are these: 1. A greater power of overcoming resistance, by which the central organs are powerfully affected; 2. A power of producing muscular contractions in cases where the faradic fails; 3. A far more potent catalytic, electrotonic, chemical, and thermic action. The advantages of the faradic over the galvanic are these: 1. By virtue of its frequent interruptions it more easily produces muscular contractions when passed over the muscles or nerves that supply them; 2. It produces greater mechanical effect; 3. It is less likely to produce unpleasant or harmful effects when incautiously used than the galvanic.

The general differential indications for the use of the two currents may be thus summed up: the galvanic should be used, first, to act with special electrolytic power on the brain, spinal cord, sympathetic, or any part of the central or peripheral nervous system; second, to produce contractions in paralyzed muscles that fail to respond to the faradic; in electro-surgery, to produce electrolysis or cauterization. The faradic should be used, first, to act mildly on the brain, spinal cord, sympathetic, or any part of the central or peripheral nervous system; second, to excite muscular contractions

wherever the muscles are not so much diseased as to be unable to respond to it; third, to produce strong mechanical effects.*

Methods of electrization. There are in medical electricity two principal methods of applying the current, termed respectively localized and general electrization. Under these two heads may be included every variety of application with either the galvanic or faradic currents.

Localized electrization. To Duchenne is due the credit of having at least systematized the method of localizing currents of electricity in special nerves, muscles, and organs of the body. Localized electrization, however, had for years previous to this time been used both in this country and in Europe. Duchenne, keenly alive to the practical importance of the subject, as well as the almost universal neglect under which it had been struggling for place and position, bodied it forth, as it were, into visible shape, and gave it a local habitation and a name. The leading idea of this method of Duchenne was that the electric current can be localized over a fixed point *under* the skin, if well-moistened conductors are strongly pressed *upon* the skin. This conclusion was reached and readily demonstrated by observing that when dry electrodes are applied to the dry skin sparks with a crackling sound are produced, but no sensation and no muscular contraction. If one electrode is moistened, the other remaining dry, contractions with the phenomenon of sensation are excited under the moistened electrode; while if both electrodes are wet muscular contraction and sensation are not only more decided, but more deeply seated. The system of electro-therapeutics and electro-diagnosis which was based on these observations has been refined and developed until it has grown into a permanent department of science.

Localized electrization may be thus subdivided: 1. Galvanization or faradization of individual nerves, muscles, and organs

* Beard and Rockwell's Medical and Surgical Electricity, pp. 153, 156.

of the body; 2. Galvanization of the brain; 3. Galvanization of the sympathetic; 4. Galvanization of the spinal cord; 5. Cutaneous faradization; 6. The electric moxa, with either the galvanic or faradic current.

For the purposes of localized electrization there are needed a variety of electrodes, of different shapes and sizes, adapted to the locality which it is proposed to influence. The method of electrifying individual nerves and muscles must be sought for in chapters on electro-therapeutical anatomy; and the art of readily and effectually electrizing the eye, ear, nose, larynx, œsophagus, heart, lungs, stomach, liver, kidney, spleen, intestines, rectum, bladder, male and female organs of generation, is described in works on medical electricity.

Galvanization of the head. In galvanization of the head one pole may be placed upon the forehead and the other on the occiput, or a pole may be placed on either mastoid process or on either temple. In making these applications it is well to remember, first, that less dizziness is caused when the current flows from the forehead to the occiput, or through the side of the head, than when it is sent from side to side through the mastoid processes; second, that opening and closing the circuit with the positive pole causes less dizziness than with the negative pole. To those who possess apparatus for increasing and decreasing the strength of the current without causing interruptions it is of course immaterial which pole is applied first.

Galvanization of the sympathetic. All ganglia of the sympathetic can be affected more or less by galvanization, but the cervical are most readily and demonstrably influenced by it. One and perhaps the most effectual method of the many employed in galvanization of the cervical ganglia is to place an electrode over the sixth cervical vertebra, while the other is placed in the auriculo-maxillary fossa. It is, however, impossible to exclusively localize the current in the great sympathetic. In the method described the spinal cord

is affected, while by other methods the pneumogastric and phrenic nerves are reached as well.

Galvanization of the spine. The spinal cord may be electrized by placing one pole a little below the occiput and the other at the coccyx, or better still, in many cases, by placing an electrode on either side of the transverse processes; one pole being two inches below the other, and gradually moving them along until the coccyx is reached. A less irritating effect is produced by placing the negative pole somewhere in the gluteal region, while the positive is applied to the spine. By this method we put the cord in the so-called condition of anelectrotonos. In using the galvanic current, and especially when the central nervous system is submitted to its influence, it should never for one moment be forgotten that its power for evil as well as for good is very great; and in every application in morbid conditions of these organs the current should be most carefully graduated, and every resulting symptom of its use accurately noted.

Cutaneous faradization, etc. Cutaneous faradization is accomplished by thoroughly drying the skin, and applying the current through dry metallic electrodes or the dry hand, while the electric moxa is produced by applying rapidly to one part a dry and finely-pointed metallic electrode. The first method is extremely useful in conditions of profound cutaneous anæsthesia; the second is frequently employed successfully as a counter-irritant in obstinate cases of neuralgia.

General electrization. The object of general electrization is to influence more or less thoroughly by the electric current the various tissues and organs of the body. The most thorough form of application demands that the whole surface of the body from the head to the feet should be brought in contact with such electrode as may be used in the operation. To effect this it is customary to place the feet of the patient upon a metallic plate, to which the negative pole is attached, while the positive pole is applied to the surface generally.

In these operations the faradic current is chiefly employed, although the galvanic may sometimes be used with advantage in those occasional and peculiar cases where the whole nervous system seems to be in a measure insusceptible to any ordinary stimulation.

For a number of years it has been customary with us to substitute our hand for the ordinary sponge electrode, especially when operating about the head and neck. No artificial electrode that can be devised equals the human hand in flexibility and power of adaptation to the inequality of surface in the face and neck, and one needs only to accustom himself to the passage of the current through his hands and fingers to become practically aware of the immense advantage given him in treating all such sensitive parts. Excessively sensitive women will bear and be benefited by this method of treatment, when the application of the same strength of current through any artificial electrode would not be for an instant tolerated. It is hardly necessary to add that the powerful chemical and reflex effects of the galvanic current contra-indicate its use to any extent through the person of the operator.

This method of general electrization, which was first systematized and introduced to the profession five years since by my associate, Dr. Beard, and myself, has now been thoroughly tested, not only by ourselves in a series of more than twelve thousand applications, but by a number of others who have had the patience to persevere in its use. Electricity, and more especially in the form of faradization, is not a mere stimulant, the effects of which pass away as rapidly as they are made manifest. It is a *tonic* of vast and varied powers, and as such is indicated in a large number and great variety of disorders.

Accumulating experience has compelled me to modify and even reject many of the ideas originally held in regard to electro-therapeutical indications; but this main idea of elec-

tricity as a tonic I still hold, and every month's experience does but confirm and strengthen my belief. In general electrization, as in other forms and methods of treatment, correct conclusions are reached only by continued and patient observation. He who submits the method to this test will find that its stimulating tonic effects may be divided into three classes: 1. Primary or stimulating effects, or those which are experienced during or immediately after treatment; 2. Secondary or reäctive effects, those which are experienced one or two days subsequent to the treatment; 3. Permanent or tonic effects, those which remain in the system as a permanent result of treatment. The secondary or reäctive effects are not as a rule manifest in the treatment of a robust, healthy person. It is in those cases of nervous exhaustion, and in debility following organic disease, that they are especially noticeable.

From the above very brief and necessarily incomplete description of this method of operation I would by no means have it understood that its effective use requires no careful study nor close preliminary experience. General as well as localized electrization is the property of that physician only who will take the requisite pains to initiate himself into its immediate and remote effects, its indications and rationale, and become practically familiar with its *modus operandi.* It was lack of familiarity with these things that induced medical men for so many years to accord to the study of electro-therapeutics a position no higher than the compounding of a pill or the administration of an enema. This is certainly one of the most remarkable instances of misconception on the part of a great and liberal profession of which we have record.

Paralysis. The utility of some form of electrization in paralysis has long been an accepted fact; and even to within a very short time this disease, or symptom of disease, has been regarded as *par excellence* the condition for which electricity is indicated. Electrization is without doubt *par excellence* the

remedy, but if it accomplished nothing more in other disorders it would certainly be undeserving the position we claim for it. In cases of hemiplegia both general and localized faradization and galvanization are frequently of important service. Under one or both of these methods of treatment I have seen the utterance become rapidly more distinct, the strength improved, and the paralyzed limb, which was progressively atrophying, increase in the course of a few months to the size of its fellow. These results, however, are not uniform; and in conditions of extensive central disorganization the utmost care should be exercised in all operations, especially with the galvanic current, about the head and neck. In the case of the late Prof. Geo. T. Elliot the slightest galvanic or faradic influence near the brain or sympathetic caused immediate and alarming dizziness. Post-mortem examination in his case revealed a remarkable condition of fatty degeneration of the cerebral arteries. Facial and other forms of local paralysis, when not dependent on structural change, generally recover with great rapidity. Paraplegia, however, upon whatever cause it may depend, is the most intractable of all forms of paralysis. In these cases, when the cause is of central origin, the faradic current is powerless to produce contraction of muscles, and occasionally no form nor intensity of current is sufficient to disturb their repose. Glosso-laryngeal paralysis is sometimes temporarily benefited by faradization of the pharynx and tongue, thus relieving in some measure the difficulty in deglutition. The disease, however, is almost surely fatal. In lead paralysis the galvanic current is of service, although beneficial results are slowly obtained. Progressive muscular atrophy presents but an unfavorable prognosis under any method of treatment; but some suggestive results, occurring in our own experience and in that of others, lead us to believe that all cases are not altogether hopeless.

Anæsthesia. Anæsthesia is a symptom dependent on such a variety of causes, both functional and organic, that the re-

sults of treatment are necessarily varied. Taking the cases, however, as we find them, without regard to causation, it will be found that in the majority this annoying symptom yields with remarkable readiness to general faradization, or to the electric brush with the same current. Even when structural change is evident in the peripheral nerves or their centers the galvanic current, directed not alone to the benumbed part, but to the seat of trouble as well, not infrequently improves the sensation at once.

Progressive locomotor ataxy. This is a disease for which electrization is invariably indicated. The late Prof. Remak claimed to have cured quite a number of these cases; but in carefully examining accounts of symptoms as detailed by German writers it is evident that many of their diseases termed ataxy do not certainly depend on atrophy of the cord. I have never seen a complete recovery from this disease; but in the thorough treatment of more than a dozen cases by galvanization of the cord, together with general electrization, quite a number have without doubt been arrested in their course; have indeed improved; and in almost every instance some marked and important amelioration of symptoms have been manifest. The severe neuralgic pains seem to be invariably lessened.

As an illustration of what may frequently be accomplished in such conditions I refer to the case of Mr. D. H., aged forty-nine. This patient consulted me some eighteen months since, complaining of persistent numbness of the hands, feet, and ankles; neuralgic pains in the lower extremities; insomnia, with excessive nervousness, together with a very decided lack of coördinating power in the movements of the legs. The first of these abnormal symptoms were noticeable about a year before he fell under my observation, but it was not until four months previously that they began to increase in severity with alarming rapidity. I referred the gentleman to Dr. John T. Metcalfe, who at once confirmed the diagnosis of spinal

sclerosis, and highly approved the treatment proposed, viz., spinal galvanization and general faradization. The patient was remarkably insusceptible to the influence of either current in the beginning; but as the treatment progressed increased acuteness of sensibility became decidedly manifest in the hands and feet, while the neuralgic pains were dissipated, and the power of coördinating the movements of the lower extremities markedly improved. Sleep became natural, and several other deranged functions improved with the above changes.

After four months of treatment it was found that further improvement was impossible, in consequence of which the patient was advised to discontinue his efforts at least for a time. The results accomplished, however, were extremely gratifying; and more especially since to this time, more than a year since the last application, all the improvement obtained has been retained.

Neuralgia. If electrization was serviceable in no form of disease other than in neuralgia, the measure of benefit derived from its use in this terrible malady would entitle it to our most earnest consideration. The kind of current to be used, its tension and direction; the mode of application, whether by general or localized faradization, central or peripheral galvanization, galvanization of the sympathetic or the electric brush or moxa; all these considerations require for their elucidation more time and space than this brief presentation commands. In this disease, as decidedly perhaps as in any other, the treatment at the outset should be tentative. By an injudicious application the severity of the pain may be much increased, and not infrequently neuralgia has been produced by over-excitation of the healthy nerve.

As an illustration of the difficulty of laying down special and exact rules in the treatment of this affection, I may refer to a lady patient who suffered excruciating pain along the course of the supra-orbital nerve. In most neuralgias gentle currents tend to soothe, while those of great intensity serve

to aggravate, the distress. In this instance a galvanic current from only two cells, and a faradic current at its minimum, greatly aggravated the pain, while a faradic current of such tension as to be absolutely unbearable on the healthy side immediately relieved the neuralgia when applied over the diseased nerve.

Spinal irritation. Spinal neuralgia would seem to be a more suitable term to express the conditions of spinal tenderness, shooting pains, and excessive exhaustion implied by spinal irritation. But, however much ideas may differ as regards the pathology of the so-called spinal irritation, there can be no doubt (among those who are familiar with the varied therapeutical uses of electricity) concerning the great value of the galvanic current in the condition under consideration. The descending current—the negative pole being firmly placed on the gluteal region, while the positive pole is applied as nearly as may be to the seat of tenderness—generally works a favorable change after a few applications. In most cases but five or six ordinary cells should at first be used. Not infrequently a current of even less tension is followed a few hours after treatment by considerable prostration; but in my experience this effect is in a short time almost invariably superseded by increased vigor and relief of pain.

In chorea, epilepsy, rheumatism, gout, and catarrh, the disorders of menstruation, aphonia, and anæmia, the results of treatment by electrization vary with the numberless changing circumstances which accompany and are a part of each individual condition.

Chorea—Epilepsy. In its most aggravated and persistent form chorea is frequently treated with remarkable success. Galvanization of the brain, sympathetic, spinal cord, and of the affected muscles have all afforded relief; but in my hands general faradization has succeeded best, has indeed been followed by speedy recovery after all methods of electrization and medication had failed. Few, if any, complete recoveries

from epilepsy from this method have been recorded. Galvanization of the brain and sympathetic, and even powerful faradization in the region of the sixth cervical vertebra, have, in a number of cases in my experience, been followed by the same degree of amelioration as occurs from the use of bromide of potassium; but in most instances its effects were soon lost.

Rheumatism — Gout. These diseases are without doubt frequently benefited, in a greater or less degree, by electricity. Both conditions are so capricious in their symptoms that it is often impossible to estimate the degree of benefit derived from any remedy. Muscular rheumatism, however, yields in many instances most readily and delightfully to localized faradization.

Amenorrhœa—Dysmenorrhœa. Amenorrhœa is a symptom that yields perhaps more readily to some one of the many forms of electrization than to any or all other methods of treatment. In cases dependent on or associated with general debility general electrization is of course indicated; but where all external efforts have been fruitless internal electrization is not infrequently followed by an immediate and satisfactory flow. As an illustration of this result I give the following:

Mrs. H., aged thirty-nine, had not menstruated for nearly a year. She was not anæmic, neither was her strength much impaired. The uterus was slightly anteverted, but there was no evidence of ulceration or congestion. The most annoying symptom of which she complained, and which had persisted for several months, was a spasmodic contraction of the organs of deglutition whenever she attempted to eat or drink. This condition had increased in severity so that on occasions she was unable to take food sufficient to satisfy the cravings of hunger. For several days I made trial of general faradization, together with localized galvanization, but with no result. With the patient's consent an internal application was then attempted. I introduced a cup-shaped metallic electrode to the uterus, so that the os was completely surrounded, and

applied the positive pole firmly against the abdomen immediately above the pubes. The current, which was of considerable strength, I reversed rapidly a number of times during the seance, and on the following day repeated the application. In less than six hours after the second attempt slight signs of returning menstruation were manifest, and steadily increased until, as regards quantity, the flow was quite natural. The patient was immediately relieved of all her distressing spasmodic symptoms, and at the present time (three weeks having elapsed since treatment) still remains free from them.

Dysmenorrhœa of a neuralgic character it is possible at times to benefit speedily; while menorrhagia, which so often depends on a condition of debility and relaxation, is not infrequently relieved by a short course of general electrization.

Catarrh (rhinitis). In connection with the use of the posterior nasal syringe, the galvanic current is most effectual in relieving chronic catarrh of the nasal passages. I speak on this point with much confidence, since I can refer to several cases of catarrh of years' duration that were cured completely and permanently and mainly by localized galvanization. One of these cases to which reference might be made was referred to me by Dr. Roosa, of New York. The patient, a lady aged thirty, had suffered from an aggravated form of the disease for eight years. The symptoms had resisted ordinary methods, but under the treatment described recovery was complete in three months.

Nervous aphonia. This condition is occasionally relieved by external application of either the galvanic or faradic currents, but our main reliance most be in applications directed to the chordæ vocales and surrounding parts.

Disease of the male genital organs. The beneficial results accruing from the use of electrization in certain diseases of the male genital organs would, if time permitted, justify some extended remarks in this connection. In both spermatorrhœa and seminal emissions uniform results are not to be expected,

so dependent are they for cause and continuance upon contingencies beyond the physician's control. The reproductive function is so intimately connected with the central nervous system that in many cases of spermatorrhœa, especially when associated with hypochondriasis, galvanization of the brain, spinal cord, or sympathetic exerts a direct beneficial influence. This method, combined with localized faradization and galvanization, is measurably successful. Cases of impairment of sexual power offer even a more uniformly favorable prognosis, so far as electrical treatment is concerned, than the conditions just considered. So encouraging indeed has been the average result that in no case, after ordinary remedies have proved unavailing, should the patient fail to be submitted to the influence of electrization.

Nervous exhaustion. It is in the treatment of the various forms of functional nervous affections, of which excessive debility is the principal symptom, that the tonic influence of general electrization is most decidedly and satisfactorily manifest. Cases of nervous exhaustion are so uniformly relieved by a persistent course of general electrization that when they obstinately resist its influence we have good cause for suspecting the existence of unrecognizable organic disease. Many conditions which are even thus complicated are relieved in their symptoms, although ultimately they may progress to positive disease of the nerve centers.

Nervous dyspepsia. In nervous dyspepsia general electrization is as effective for good as in the above-mentioned condition; and hypochondriasis, both as a symptom of dyspepsia and as a distinct affection, yields in many cases most readily to treatment.

Electrolysis. The limits of this paper will not admit of any extended or very satisfactory discussion of this subject and its application to disease. It is well known that when any fluid containing salts in solution is submitted to the action of the galvanic current certain interesting and uniform results may

be observed. Iodide of potassium, which is very readily decomposed, yields at the positive pole iodine and oxygen, and at the negative pole hydrogen and alkali, and the solution is soon changed to the color of iodine. In electrolyzing raw meat we find that oxygen, acids, and albumen go to the positive pole, while hydrogen, alkalies, and coloring matter go to the negative; and in proportion as its watery constituents disappear the meat becomes dry and changed in color, and as the disintegrating process goes on the parts near and between the poles shrivel and harden until they assume the appearance of a charred mass. The law governing this disintegrating or electrolyting process may be thus stated: if chloride of sodium, acetate of lead, and water are electrolyzed, the chlorine, peroxide of lead, oxygen, and hydrogen which are evolved are definite in quantity, and are electro-chemical equivalents of each other; and according to Faraday, who discovered this law, the electrolytic power of a current of electricity is in direct proportion to the absolute quantity of electricity which passes. When we come to test these principles in the treatment of morbid growths and other diseased conditions, it is found that the results are such as to excite much interest even among the most skeptical. That the electrolytic power of the galvanic current is sufficient in many cases to dissipate tumors, both malignant and non-malignant, is beyond question; and that it is able, by reason of its subtile diffusive influence, to destroy more completely and thoroughly the reproductive power of malignant growths than the knife or caustics, can hardly be doubted.

Rapid effects in a case of scirrhus. One of the most remarkable instances of the rapidity with which it is possible, under favorable circumstances, to influence a cancer by electrolysis occurred some months ago in an operation which I performed for Prof. Frank Hamilton in the presence of the medical class of the Bellevue Hospital Medical College. The patient was a woman afflicted with a true scirrhus of the breast, about

the size of a small orange, and extending far into the axilla. Two operations, ten days apart, not only relieved the patient of every trace of the intense pain from which she had so long suffered, but entirely dissipated all enlargement of the axillary glands, and reduced the size of the tumor more than one half. Our clinical note-book affords a number of tumors of different character treated with complete success by means of electrolysis, but time will not allow me to give any detailed account of them in this connection.

Erectile tumors. Erectile tumors especially are so uniformly cured by this method, and with no resultant scar or other ill effect, that it is really a pleasure to operate upon them. In the case of a little child about a year old, upon whose face, near the angle of the lower jaw, a tumor of this character had existed from birth, electrolysis was completely successful. The patient was placed under the influence of chloroform, and two platinum needles, insulated to within one third of an inch from the points and connected with the positive pole, were introduced into the two lower quarters of the tumor; while two steel needles, connected with the negative pole and insulated in a similar manner, were thrust into the two upper quarters. The current from twelve medium-sized cells of a zinc-carbon battery was allowed to pass for ten minutes, at the end of which time the coagulation of the blood was complete. Absorption of the clot rapidly became manifest, and in four months it had entirely disappeared. In subsequent operations I have used steel or gold needles at the positive pole, since the oxidation which these metals undergo in all probability tends to accelerate coagulation.

In referring again for one moment to cases of scirrhus I would remark that where electrolysis, as is sometimes the case, fails to produce any marked impression when its action is confined to the diseased mass, it may be proper to circumscribe the base of the tumor by introducing ten or twelve needles. By this method the current will indeed act upon

the muscular tissue beneath, but it is followed by no bad results, while the cancer itself can be made to slough off.

Galvano-cautery. One great objection to the use of the galvano-cautery has been the difficulty of obtaining and managing the necessary apparatus. This difficulty is now being very successfully met, and such apparatus as is needful for most of the purposes of cautery is readily obtained. It has been more or less successfully employed for the removal of tumors, cauterization of ulcers, treatment of fistula, amputation of diseased organs or parts of organs; treatment of neuralgia by cauterization, and so killing the nerve; treatment of prolapsus uteri by cauterizing the vaginal walls with the burners, and thus causing inflammation, suppuration, and cicatricial contraction. In the amputation of such parts as the neck of the uterus, polypus in the throat, etc., that are difficult of access, this method is invaluable. The platinum wire can be accurately adjusted before being heated. There is little pain after the operation, and it saves all hemorrhage. Its use is undoubtedly destined to be greatly extended.

In the foregoing pages I have endeavored to give as compactly as possible some general idea of the distinguishing features of the different forms of electricity, and the very extensive use to which it may be put in the treatment of disease. We claim for it no greater consideration nor higher place than clinical experience justifies. Like other remedies, it has its ardent and indiscreet partisans, but above all other remedies has it been neglected and condemned.

New York.

PRESENT STATE

OF

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By A. D. ROCKWELL, M. D.

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