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# Electrotherapeutics: Its Applications in Medicine

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# ELECTROTHERAPEUTICS- ITS APPLICATIONS IN MEDICINE

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The scientific application of electricity to the human body for the treatment of disease has recently been greatly stimulated by its remarkable commercial development.

Electrical science is really of modern origin, new principles and new economic applications being announced daily.

It is unfortunate and sometimes embsrrassing, to the medical student particularly, to find confronting him at the very threshold of the subject a mass of literature, come down from a period when purely emperical methods prevailed, and the nature of this force and its effects, both physiological and therapeutical were very imperfectly understood. But the ingenuity of electricians and expert instrument manufacturers has been attracted in this direction and brought to our aid apparatus of precision, both for therapeutics and for diagnosis, with which it is the duty of every student and physician to acquaint himself.

Many who are mere charlatans bring discredit upon medical electricity by claiming to be specialists, when they are ignorant of the first principles of medical or physical science. It should be an easy matter for one acquainted with the therapeutics of electricity, as all medical men should be, to expose such impostors. He should not only be versed in electrical science but should also have a good anatomical and physiological knowledge; he should also be familiar with pathology, im its most comprehensive sense, in order to give a correct

diagnosis and prognosis as regards the utulity of electrical treatment, so that it may not be brought into disrepute by being misused.

It is not my intention in this brief paper to discuss the laws underlying the electrical manifestations, the electromotive force, the intimate relationship of electricity and magnetism, and the like, but to give a description of some of the apparatus and appliances used, the manner of using them, the indications for their use, its effects and results.

The chief forms of apparatus for the generation of electrical energy are the (1) Galvanic cell, (2) Foradic coil, (3) Static apparatus, (4) Magneto-Electrical machine or Dynamo and (5) Storage Batteries.

Galvanic cells consist of two plates zinc (positive) and copper (negative) partly immersed in a fluid (dilute H2·So4) which acts chemically upon one and conveys the current across to the other. The great fault in these batteries is that the current is not constant but will vary from zero to full strength; this is due to several causes which need not be explained here. There are several different forms of these cells, which generally work with a closed circuit and is used chiefly for telegraph work.

The Faradic coil, which usually has its source from a galvanic cell, consists of rolls or coils of insulated copper wire; electrical phenoma are shown and currents started or broken. These are very powerful if the primary wire is placed inside of the secondary or induction coil.

The wires must all be properly insulated from each other and the electro-motive force is directly in proportion with the number of coils of wire brought under the influence of the lines of force and a fine wire, especially in the secondary coil, will yield a greater current of electro-motive force than a coarse one.

The Static or frictional is the oldest form of electricity known. It is produced by rubbing glass or amber with some non conducting material. The ordinary form is that of a circular plate of glass, which is made to revolve rapidly in such a way that it is slightly rubbed with an exciting material, the glass and rubber being insulated from each other and connected with terminal posts, from which the current may be taken. Electricity of this character is confined to the surface of bodies and can be confined or stored up in an apparatus, as the Leyden jar. The Holtz apparatus is one of the best of induction machines and has been used by many with marked success.

The fact that a magnet introduced into the interior of a coil of wire is capable of disturbing its electrical equilibrium and starting electrical impulses has led to the construction of medical electrical machines, in which coils of wire, attached to a revolving frame, are made to pass rapidly through the line of forces around the poles of a large magnet. Currents are set up in the coil as it enters and as it leaves the magnetic field, and by connections those currents are conveyed to electrodes, by which they can be applied to the body. These constitute the magneto-electrical machines.

The Storage Battery is a term applied to a form of apparatus in which chemical action produced by a current of large volume and low pressure is used to yield a current of electro-motive force. This formerly consisted of two insulated plates of lead immersed in dilute H2 So4. The current is passed through these plates till one is oxidized, it is then reversed when the other plate is oxidized and the first one oxidized. The plates are now formed, the oxidized one being positive and the other negative.

At present the Faure cell or dry plate is most convenient. They are lead plates which contain numerous perforations, filled with lead oxide, mixed into a paste with sulphuric acid. The red oxide is used for the positive and the yellow oxide for the negative.

After the plates have been thus prepared they are formed by passing a current through them while immersed in dilute sulphuric acid. This form is largely used in medicine and surgery, in connection with the galvano-cautery, dental engine or drills and to furnish light for exploratory purposes.

In addition to the supply of electrical energy for medical use certain apparatus is needed. We must have current carriers and electrodes, adapted to the part of the body they are intended to be applied to. As a metallic electrode causes pain when strong currents are used it is customary to cover the electrode with a moist sponge or soft leather, or even a moist layer of absorbent cotton. When large currents are used it is necessary to increase the size of the electrode in order to avoid electrolysis of the tissues and even a mass of moist clay may be applied over the surface of the body. Electrodes

for cautery work are usually made of platinum. This is heated to the desired degree as the current passes through the miner loops.

A peculiar electrode, attached to an electric bell is used when searching for bullets. The bell will ring whenever metallic connection is made. The utility of electricity in medicine depends on its power of producing physiological effects and stimulating certain functions.

It is known that all muscular movements are attended by the liberation of electrical currents and as proven by Galvani's celebrated experiment a form of battery may be made entirely of muscles. And conversely currents of electricity, made to traverse a muscle in its normal state, will produce contractions. If an electrical current be applied to a motor nerve, by introducing part of its trunk in the circuit, the muscle to which it is distributed will contract; sensations of pain or numbness will be caused by stimulating a sensory nerve; a peculiar taste in the mouth is caused by passing electricity through the gustatory nerves; sensations of flashes of light are caused by exciting the optic nerve; peculiar sounds in the ear by exciting the auditory nerve. So we have learned that properly adjusted currents of electricity cause responses in accordance eith physiological function of the organ to which it is applied. Comparatively little is known with regard to the condition of the deeper tissues of the interior of the body during the passage of a current between the anode and cathode, when applied to the surface of the body.

If the electrodes are dry, the current penetrates with

difficulty, since the dry skin offers a very high resistance, and is a poor conductor of electricity. If the electrodes are moistened with a saline solution, a small part of the current passes directly through from one to the other in a straight line, but the greater part is deflected by various routes of less resistance, a considerable part probably following the layers of fascia and blood vessels under the skin.

When a nerve-trunk is included in the path of the current, the part of the nerve near the anode is in a condition of decreased irritation and that near the cathode of increased irritation. In the normal condition the greatest effect, therefore is observed under the negative pole. By numerous experiments it has been found "that the contraction occurs with the weakest current, with cathodal closing; the anodal-closing contraction requiring twice the strength of current; the anodal-opening contractions about the same; while the cathodal-opening contraction requires four times as much." (Wilson)

As a therapeutic expedient electricity belongs to a class quite distinct from the ordinary remedies; it is simply a force in its different forms. This distinction is very marked between material substances like drugs, which temporarily become a part of the human body, and during this time affect certain functions and produce disturbances of nutrition, which may ultimately be beneficial. But the forces of electricity act directly upon tissues and cells, exciting normal irritation of muscles and nerves, and when properly and successfully used, aiding the functions of organs and strengthening vital powers.

A current of ordinary strength from a galvanic battery,

passing along a motor nerve and muscle, causes contraction of the muscle at the time of making and breaking the circuit; but during the time the current is passing uninterruptedly no motion occurs, The nerve, at this time, is in a peculiar state or condition known as electrotonus. Dr. Wood accounts for this condition on the hypothesis that the chemical constituents of the nerve trunk obeys the laws of electrolysis, by which alkalies and hydrogen will appear at the negative pole and acids and oxygen at the positive, the effect on the nerve being to a certain degree chemical. When rapid reversals are made the muscles to which the nerve is distributed will be thrown into tetanic contractions and a like condition occurs in certain morbid states from the application of faradic currents of moderate strength. The faradic current is more irritating and stimulating than the galvanic; but when the interruptions are rapid (one or two hundred per second) the secondary faradic current becomes sedative and a very fapid current often exercises an anaesthetic effect upon the peripheral nerve-endings. Prolonged tetanization of muscles without intervals of repose will cause a loss of weight; but it has been experimentally proven that a muscle stimulated by means of an induction coil current as arranged by alternating shocks and intervals as to approach the condition of a muscle during the performance of rhythmic gymnastic movements, will gain 40 per cent of weight. The loss in weight depended upon the destruction of muscular fibers, while the gain was due to a true increase of muscular tissue. In patients who suffer from imperfect metabolism, especially neurasthenics, this

is beneficial but when tissue metabolism is increased its influence is generally unfavorable.

For general diagnosis the patient is made to sit on a stool, with as little clothing on as convenient, and a large flat electrode (positive) covered with a wet napkin or absorbent cotton, is applied to the sacrum, or the patient may be allowed to sit on it; or if this is inexpedient, the feet may be placed in a basin containing warm water, in which the electrode is placed, connected with the secondary or primary coil of a faradic apparatus. The negative electrode is then applied to the spine commencing with a moderate current, and slowly carrying the electrode down the patients back, upon each side of the vertebrae, noticing any effect which may occur, especially if tender spots are discouvered. Anaesthesia or hyperaesthesia may be found, and if so the coil distance should be recorded. Pain is not necessarily an indication of inflammation, nor congestion, but these are common causes. When the electrode is passed over bony prominences pain is usually felt; even the ribs are sometimes painful under its applications, which is probably due to the effect of the current upon the periosteum or intercostal nerves.

For testing cutaneous sensibility the wire brush is useful; in this case, one electrode is placed between the shoulders and the active electrode is placed alternately upon similar points on opposite sides of the body, when any change or difference may be noted. Paraesthesia is a common symptom in many lesions of the brain, spinal cord, and peripheral nerves; but in the early stages of neuritis there is

hyperaesthesia, which may also occur in hysteria and some of the reflex neuroses. When testing for paralyzed muscles of the arm, have both arms and chest of the patient bare, place a large wet sponge, upon the sternum connected with the posl-tive pole, and apply the negative pole to the motor points of the muscles of each arm alternately and the difference is readily apparent. The current should be just strong enough to produce contractions in the healthy muscles, with an additional amount necessary to produce contractions in the paralyzed muscles. The patient must allow the limbs to be perfectly passive during the examination, and if anodal closing contractions, and several trials confirm the observation, then degeneration may be positively diognosticated.

According to Dr. Wood, when a lesion is in the cord above the dorsal enlargement, the nerve and muscle reaction will be normal below the trophic centre, except that there may be some increase in response to the electro-stimulation. If the lesion involves the dorsal enlargement there is reaction of degeneration. If the lesion affect the basal ganglia of the brain or hemispheres there will be no change in the normal nerve muscle unless the disease produces changes in the cord, thus also affecting the peripheral nerves. In a hemiphlegia resulting from a clot in the corpus striatum, there will be no change in the reaction, except that the muscle may respond more readily than normal to both currents. In old cases, there is a decline, both in nerve and muscle, due to degenerative changes.

In anterior poliomyelitis, infantile paralysis, and in lead-palsy the reaction of degeneration is present and absent

in cerebral, hysterical, myeletic and myopathic paralyses. In cases where the reaction of degeneration is limited to a definite, peripheral, neuro-muscular area the probabilities are in favor of a diagnosis of a peripheral lesion. But when the degeneration phenomena are observed over a larger area, a central spinal origen of the paralysis is rendered probable.

In the severer forms of rheumatic, traumatic, or pressure paralyses the reaction of degeneration is evident, but in the light forms of reaction is generally normal. In muscular wasting or simple atrophy, as in phthisis, disease of joints, idiopathic myositis and the like the reactions are normal. In the great majority of cases of neuralgia, where firm pressure over the affected nerves aggravates the pain, the galvanic current is indicated; if pain is not increased by pressure the faradic current should be used. Hysterical hyperaesthesia calls for the faradic current. While it is impossible, in most diseases, to say that a particular current is indicated to the exclusion of others, it is possible to name a variety of conditions where, one method of treatment with one form of current is superior to others. The faradic current is indicated, for tonic effects, in cases of general debility.

Asthenopia , accompanied by hyperaesthesia of the retina and ciliary nerves, seems to require the faradic current; also paralysis following diptheria. Galvanism is particularly useful in special irritations, neuralgia, sequelae of cerebro-spinal meningitis, exophthalmic goitre, skin affections and restoration of sense of taste or smell. In general we may say

that galvanism is indicated in the well-nourished, and faradism in those whose general nutrition is impaired. A prominent medical writer reports a case of traumatic neuritis in which electricity proved of much value in aiding the diagnosis. "A man aged 49 received an injury to his shoulder under circumstances which would have entitled him to some compensation if any permanent damage had been done. When the swelling had gone down he complained of great pain in and around the shoulder, and of inability to raise the arm. It could not at that time be determined whether this was due only to the pain, or whether there was loss of muscular power. There were tenderness and pain in the areas supplied by the supra-acromial branch of the cervical plexus and circumflex nerves, and some hyperaesthesia of this region. In the course of the next few months the pain and weakness remained about the same, and it was found that the circumflex nerve gave reaction of degeneration. This set all doubt as to the existence of a trumatic neuritis at rest, and the patient succeeded in obtaining compensation without going into court."

Dr. Wood places great emphasis on the use of the faradic current for the treatment of muscular rheumatism. A coil that gives a steady current must be used, and only so much as produces a distinct vibratory sensation without any pain. Before applying the electrode see that the skin is thoroughly dried and well powdered with a good conductor, powdered clay being as good as can be used. The active electrode should be of round, polished metal, kept warm and dry; the passive may be a small sponge held in the hand or applied to any part of the body. Begin with a force scarcely felt and slowly increasing

keep the active pole in constant motion over the painful muscles, observing carefully to avoid contracting a single fibre for if muscle contraction be produced no good results. All the force must be spent on the skin or terminal nerve filaments, which are really the seat of pain in this disease. Every inch of skin covering painful parts should be carefully gone over with the current, using a steady, slight pressure, for about one half hour, and the application repeated twice daily until the case is well.

Not much success has yet been attained in the treatment of anticular rheumatism although some report good results. In the various forms of neuralgia electrical applications have been found beneficial. The negative pole is applied near the nerve centre, and the positive moved over the different painful parts of the affected nerves. The current should usually be very mild; not to exceed three or four milliamperes.

Electric Cataphoresis by means of which medicaments are carried through the skin under the action of electricity is a valuable addition in the treatment of neuralgia. The wetting of the active electrode with chloroform will lead to its absorption. Cocaine, aconite or any soluble alkaloid may be and one operator is said to prefer cocaine cataphoresis to the hypodermic injection.

In gall-stone colic with impaction, good results have been obtained by passing brief currents of high intensity; the electrodes being placed in the hypochondriac region. The stimulus produces contraction of the fibres entering into the common duct, and the consequence is that the stone is discharged

into the intestine.

The favorable influence exerted by electricity over nutritive processes and cell-groth has made it the indispensable remedy in the treatment of various forms of paralysis, whether due primarily to nerve or muscle. Hygienic remedies, such as massage, baths and passive exercise must not be neglected at the same time.

Spasms, contractures, chorea, epilepsy and writers' cramp have been greatly benefited by the electric current as well as by the rest cure. In endometritis and uterine haemorrhages Dr. Massy has employed electricity with marked success. The positive pole is attached to the intra-uterine sound, the negative being connected with a large abdominal plate electrode. Probably no agent of the Materia Medica will check heamorrhages so effective and promptly as the positive pole; it is preferable to the ordinary mineral or vegetable astringents or styptics. Even in cases of myoma or cancer, the effects of the positive pole have been highly successful, while in ordinary menorrhagia, due to pathological conditions of the mucosa, it is curative after a few applications. Sterility may result from continued application. In cases of stricture of the oesophagus, rectum or urethra very mild currents are employed, as the principal object is to cause the absorption of the inflamatory exudate, or scar tissue, which softens under the influence of the current; there being no charring of tissue and no subsequent sloughing.

Insulated urethral sounds are used, terminating in an exposed olive-shaped bulb, which should be a little larger than the calibre of the stricture. After being made thoroughly

aseptic, this is passed down to the tender spot in the urethra and the negative cord attached; the other electrode, covered with a sponge is then applied to the thigh; the current is then gradually turned on and the sound gently pushed through the stricture, allowing it to make its own way till it passes through; the circuit is then opened and electrode withdrawn. The sittings should not exceed five minutes about every third day, and generally require ten or twelve applications.

In various forms of inflamation of the skin electricity may be judiciously employed, especially in the more chronic forms. In eczema, herpes zoster, acne, rosacea and the kindred evils it is very valuable; also keloids, hypertrophied scars, warts, moles, fibromata of the skin, and vascular naevi have been successfully treated.

Electrolysis is now very generally employed in destroying hair-bulbs growing in abnormal situations. When properly used this method causes neither pain nor disfigurement but permanently removes the source of trouble. The method is simple, and the instruments needed few in number; a battery yielding from one half to two milliamperes, a number twelve needle of steel or platinum and a sponge electrode are all that are required. Have the patient sit in a chair with a good head-rest during the operation, and a good hand magnifying-glass may enable the operator to introduce the needle directly into the hair-follicle by the side of the hair. The needle is attached to the cathode and the current made to pass by the patient touching the sponge of the anode held in the other hand. The effect of the current is observed immediately as the tissue

around the needle will be raised slightly and froth will issue from the mouth of the follicle. In about half a minute the hair should be gently pulled with the tweezers; if it does not come away the current should be passed a short time longer. Less pain is given by breaking the circuit by removing the hand rather than the needle. A sitting should not last longer than fifteen minutes, and the hairs destroyed should not all be from one spot, or there may be some inflammatory reaction, or even sloughing and production of scars. After the operation apply mild astringent lotions and hot water to reduce hyperaemia. If the papilla has been destroyed the hair will not return, but in some cases the papilla escapes destruction and the hair is regenerated. This may be due to a turn in the hair-shaft or inexpertness on the part of the operator. In young persons, especially, new hair papillae are constantly developing in the skin and their appearance after the operation does not always mean that it was a failure. Some experimenters endeavor to prove that the vitality of bacteria may be destroyed by the passage of a current of electricity and report good results in some cases. But I believe we hardly need expect much in this direction for sometime as it requires a current of three hundred milliamperes, and above, constantly applied for five minutes to kill the charbon bacteria, while lower degrees of intensity of current merely attenuate the culture and render it less virulent.

Electric illumination is unsurpassed in both medicine and surgery; by its means diagnoses have made which otherwise would have required the surgeon's knife.

The X-Rays, by which opaque bodies can be penetrated and

foreign bodies located, is by no means the least valuable discovery electrical progress; its application at present is more surgical than medical although it is possible that gall-stones, foreign bodies in the bronchi or intestines or stone in the kidney and kindred troubles may be detected in this way.

I have tried to set forth, briefly, a few practical facts in the broad domain of electricity, that confront the medical student of to-day.

My work is yet mostly theoretical and I am greatly indebted to Dr. Wilson from whose lectures and clinics a great part of the data for this paper were taken.

Dr. Wilson is a graduate of the University of Pennsylvania and professor of therapentics at the Ohio Medical University.

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