ELECTRICITY

AND

METALLO-THERAPEUTICS

IN THEIR APPLICATION TO MEDICINE.

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ON THE

MEDICAL APPLICATION OF ELECTRICITY.

It will be understood that in this thesis it is impossible to study all the questions that arise in the application of Electricity to Medicine, therefore I propose to confine my remarks to the exposition of those facts which appear to be the most indispensable and useful to the comprehension of its medical application.

After having resumed certain notions relative to the physical relations of this agent we must study its chemical and physiological action on the living body, then consider the aid that it can render in diagnosis; and, finally, its therapeutical application.

I. *General Physical Phenomena.*

I. Static Electricity, developed by friction, is not generally used in Medicine, but its effect is not notably different from that of the induction current (Legros and Onimus). It only affords continuous currents and currents of induction.

II. Continuous currents, which are still called galvanic or voltaic currents, are produced by chemical action: a metal, generally zinc, is acted on by an acid.* This chemical action disengages electricity in two inverse senses: a current in a direction from the fluid towards the metal, which is called the *positive* current; a weaker current directed from the metal towards the fluid; this is the *negative* current, which we generally ignore. When we speak *of the direction* of the current, we speak of the direction of the positive current.

In the battery, the electricity concentrates itself towards certain points which we call the POLES; the wires that are adopted to the poles to the points to which they are to be applied are called the *rheophores;* the extremities of these wires are called the electrodes.

The *quantity* of electricity of a battery depends upon the activity of its chemical action. The *tension* is the effort that these contrary electricities make to overcome the obstacles that are opposed to their reunion, and depends upon the number of the elements of the battery or pile.

Voltaic currents are rich in quantity and poor in tension; currents of induction are rich in tension and poor in quantity.

The battery to which reference has just been made is one of a single fluid. All batteries of this description have the inconvenience of altering very rapidly. The only one that is of much service is the Bichromate of Potassium battery, which lasts well if care be taken to withdraw the zinc when not required for use.

* *Vide* Physics.

The batteries of two liquids last for a long time, especially if amalgamated zinc be used; and, moreover, the metal is only attacked when the circuit is closed.

III. When a wire giving passage to an electrical current is applied to another in a neutral or negative state it instantly develops one in the latter; if the wires be alternately removed and approached to each other a new current is developed; but if the two wires rest motionless by the side of each other no new current is developed in the negative wire. We give the name of *currents of induction* developed in the neutral wire by this alternate approaching and removal of the wire giving passage to a current. This is called the *inducing* current; the other is the *induced* current.

This occurs whether this be done gently or brusquely. In the latter case the negative wire is traversed by an instantaneous current of electricity.

In this case the following is what is observed:—

1. An inducing current giving rise to an induced current in an opposite direction.

2. An inducing current.

The inducing electric current may be replaced by a magnet, and the same effects are produced on the negative wire. The magnet approaching the negative wire gives rise to an induced current in a contrary direction; removed from the wire, it causes a current in the same direction.

If, in place of the magnet, we employ a piece of soft iron which is momentarily magnetised by means of an inducing current, we observe that a magnet which first produced a contrary-induced current, in the second case induces a current in the same direction.

This disposition gradually augments, since this current is produced, both by an inducing current and by a magnet that induces and negatives alternately.

Induction by direct electricity is termed *volta-electric* induction; this term is also applied to the magnetism of soft iron by electricity; induction by means of a magnet is termed MAGNETO-ELECTRIC induction. Volta-electric induction with magnetism is the most frequently employed in medicine. These are the principles of the construction of volta-electric apparatus. In some pile forms the *positive* electricity, follows an insulated wire which is wound round a cylinder (bobbin), a good many times. At the extremity of this wire, there is an interrupter, which being in a state of equilibrium is in connection with the extremity of the wire which conducts the negative currents. The axis of the bobbin is occupied by a bar of soft iron which is in opposition with the free extremity of the interrupter.

The interrupter being in equilibrium the circuit is closed and the current passes; the soft iron becomes magnetised and attracts the interrupter, the circuit is broken, the iron is demagnetised, the interrupter returns to equilibrium, the circuit is closed, and so on. By these means we obtain the necessary interruptions for the production of induced currents.

When a voltaic current of a certain energy traverses a large circuit, it also produces an induced current in the same circuit; at the moment of making, this current is inverse, and consequently weakens the inducing current, at the breaking. This current is in the same direction, and consequently the inducing current is reinforced. These currents of reinforcement are called the *extra currents.* We can collect them by a wire and utilise them.

An induced current can in its turn induce a third one, which is called a current of the second order.

The apparatus of volta-electric induction most used in medicine are those of Ruhmkorff and Gaiffe, which have the advantage of giving in a small compass very energetic induction currents.

The principle of magneto-electric apparatus is the following :—

A horse-shoe magnet is fixed; round it a horse-shoe bobbin, also of soft iron, rotates in the same plane as the fixed magnet. When the two extremities of the bobbin are parallel with the magnet the soft iron is magnetised, which gives rise to an induced current; if by rotation we remove the poles of the bobbin from the magnet, the soft iron is demagnetised and a new induced current is produced; this demagnetism takes place at a quarter turn. When the bobbin has effected a half turn, it is remagnetised.

At the second half turn, the same phenomena are reproduced, in the manner that, after a complete revolution, the bobbin has become magnetised and demagnetised twice, thus producing four induced currents.

II. *Physiological Action of Electricity.*

Electric conductibility of tissue.—The tissues have not all the same electrical conductibility. The experiments of Eckhard and Ziemssen have demonstrated that muscle possesses the greatest power of electrical conduction. If the unit of resistance of muscle to electricity is represented by 1, the other tissues are represented by the following figures :—

Tendons	1·8	to	2·5
Cartilages	1·8	,,	2·3
Nerves	1·9	,,	2·4
Bone	16	,,	22

The least conductive tissue is the skin. Eckhard remarks that the conducting power of tissues is in a direct ratio to the richness of the tissue in fluids.

Thus the proportion of water represents conductibility.

Muscles	72	to	80	per cent.
Tendons	62	,,	100	,,
Cartilage	50	,,	75	,,
Nerves	39	,,	66	,,
Bone	3	,,	7	,,

Several practical consequences result from these differences of conductibility.

Whenever we wish to employ continuous currents, it is absolutely necessary to moisten the skin, for these currents have never sufficient tension to easily overcome the resistance of the dry epidermis; or, if they have sufficient power, they are very intense, and cause chemical decompositions.

With currents of induction it is also necessary to moisten the skin if we wish to act deeply.

To act on a muscle or on a nerve situated at the same level it is necessary to employ stronger currents for the muscle than for the nerve.

Course of electrical currents.—The electrical current is not propagated in a straight line from one electrode to another, but they describe curved lines more approximated to each other, according as they approximate to the line of junction of the two electrodes. The current, therefore, is less strong in this line, but this zone only extends to a certain distance from it.

With continuous currents this derivation is much more considerable, and these derived currents may manifest themselves at a considerable distance from the point of application of the electrodes. Thus when one of the poles were placed on the superior part of the spinal column and the other over the lumbar region, movements of the ears, phosphenes, etc., have been observed. Legros and Onimus attribute this fact to currents of derivation.

These currents are naturally an obstacle to localised electrisation, and as they are proportionate to the size of the electrodes, we should use small straight electrodes whenever we wish to excite a nerve or isolated muscular contractions.

Physical effects of electricity.—The physical phenomena of electricity are light, heat, and mechanical movement.

1. Electricity produces no phenomena of light on the organism.

2. There is a disengagement of heat whenever electricity experiences a resistance to its passage. Living tissues not being good conductors of electricity, it is only natural to suppose that heat is developed in them. Legros and Onimus obtained no definite results.

3. The electric current causes muscular movements, and as it is directed from the positive to the negative pole, the contraction occurs in the same direction.

Legros and Onimus have studied the phenomena of osmosis, and have found that the electrical current favours or otherwise osmosis, according as the positive pole is in connection with one or the other solution. If the positive pole is in connection with pure water and the negative with a solution of gum, the osmotic action is increased, and the level of the tube containing the gum solution is rapidly augmented. If the positive pole be placed in the gum solution the osmotic current is reversed. This influence is undoubtedly applicable to the system, but here the question is more complicated, as we must take the influence of electricity on the vessels into account.

III. *The Chemical Action of Electricity on the Organism.*

Electricity decomposes the tissues, and this decomposition is peculiar inasmuch as the saline bases accumulate at the negative, while the acids accumulate at the positive pole.

This separation of the two constituents of salt consequently has a caustic action at the two poles. At the positive pole the ulcer or slough reddens litmus paper, it is firm, dry as every slough caused by acids is; at the negative pole, on the other hand, the slough is alkaline and humid, as we observe after the application of alkaline caustics. The quantity of the tissue destroyed depends upon the quantity of electricity passing in a given time.

Electrical currents coagulate the blood at the *positive* pole; on this property is based the treatment of some aneurismal tumours.

Action on the Nervous System.

1. Motor nerves.—The continuous current has different actions according to whether it is directed from the centre to the periphery (direct, centrifugal, or descending current), or from the periphery to the centre (inverse, centripetal, or ascending current).

A continuous centrifugal current applied to a motor nerve determines a contraction at the closing and opening of the current, but the contraction at the opening is always more feeble, and with a *feeble* current we may even only get a contraction on breaking. A continuous centripetal current produces contractions both on making and breaking, but the contraction of breaking is the more feeble; and thus with a feeble current, we may only have a contraction on making (Legros and Onimus). Currents of induction applied to a nerve or muscle cause contractions; the direction of the current has no influence.

2. Sensory nerves.—The continuous centrifugal current on sensory nerves, causes sensation on making; the centripetal causes sensation on breaking only. While the circuit remains closed sensation persists but feeble. We see that continuous currents act in an inverse manner on motor nerves and sensory nerves.

With induced currents the direction is indifferent (Jaccoud). Whatever the direction of the current may be sensibility is always more acute at the positive pole. The excitation of sensory nerves may be followed by reflex contractions. On organs of *special sense* electricity causes sensations in accord with the special function of the excited sensorial nerve. In this respect the continuous is more powerful than the intermittent; and amongst the intermittent currents the magneto-electric are more powerful than the volta-electric.

3. Mixed nerves.—The action of electricity on mixed nerves can be easily deduced from its action on motor nerves respectively.

A continuous centrifugal current determines a contraction on making, a sensation at breaking, etc.

4. Spinal cord. — Continuous currents, according to Legros and Onimus, have a variable effect on the spinal cord, according as the positive electrode is applied to the upper part (descending current), or to the lower part (ascending current) of the spine.

The descending current produces no excitation of the cord, no phenomena of sensibility, no movement. Thus if the reflex functions of the spinal cord have been enhanced by experiments (section of the cord—strychnia poisoning), or by disease (tetanus), the descending current diminishes the irritability of the cord, hinders reflex movements, thus exercising a paralysing action. The ascending current, on the contrary, excites the spinal cord, causes pain and muscular contractions, even in regions where the nerves do not come directly from the segment of the cord which is excited. A practical consequence of great importance arises from this difference in activity of descending and ascending currents—the first only ought to be employed as reflex moderators, the second as reflex excitors. Induced currents excite the spinal cord whatever their direction.

5. Brain.—The experiments of Hitzig and Fritsch with continuous currents, of Ferrier with induced currents,—experiments made with the object of isolating sensitive and motor cerebral areas, demonstrate that both kinds of currents excite the cerebral convolutions. Can electricity applied to the cranium excite the brain? The experiments of Erb appear to favour an affirmative answer.

Action on the Muscles.

1. Striated muscles.—Continuous currents cause contraction on making or breaking of the current, whatever may be its direction, but the contraction of making is always greater than that of breaking (Legros and Onimus).

Currents of induction, on account of the rapidity of the interruptions, cause a tetanic condition of the muscle; therefore the muscle is more readily fatigued. The muscular contractions produced by electricity are independent of the action of the nervous system, for they take place when the muscle is withdrawn from its influence by the action of curara.

By experimenting on animals we can isolate electricity either on the nerves or on the muscles, but with man we can only act through the skin, and consequently the electricity at once excites both nerves and muscles. It is interesting to observe under these conditions whether we obtain the more energetic contractions by applying the electrodes over the muscle or over the tract of its motor nerve. Remak, Duchenne, Ziemssen affirm that electrisation of the nerve causes better contractions than that of muscle, and the result is the more marked if the nerve be superficial.

2. Inorganic muscle.—Organs into whose structure this variety of tissue enters contract under the influence of electricity; but it has not yet been demonstrated how much of this contraction is due to excitation of the muscle tissue, how much to nerve.

Action on the Circulation.

Induced currents applied to nerves excite their vaso-motor fibres, and consequently contract the arterioles and raise blood pressure.

Continuous descending currents applied to vaso-motor nerves dilate, while ascending currents constrict the vessels (Legros and Onimus).

When the electrodes are applied to the spine they generally produce redness at the point of application. This redness is indicative—is manifestly indicative—of vascular dilatation, which ought to be attributed to a reflex paralysis, comparable to that which follows all painful applications. The action of electricity on the heart is only known by its employment as a stimulant in cases of syncope.

Action on Respiration.

In the same way in cases of asphyxia, electrisation of the thorax is very useful in restoring the respiratory movements.

Action on Nutrition.

Legros and Onimus concluded from their experiments that *currents of induction* diminish the quantity of urea, that *continuous centrifugal currents* act in the same way, but that *continuous centripetal currents* augment its production and elimination.

IV. *Semiology.*

The electrical exploration of muscle contractibility is generally considered as capable of rendering great service in the diagnosis of paralyses. It is occasionally advanced that by the means of electricity a paralysis of cerebral, spinal, or peripheral origin can be differentially diagnosed.

But this is an exaggeration. Electricity can only enlighten us upon one point—viz., the normal or pathological condition of the muscles or nerves. When the muscles and nerves are not altered the electrical contractions are normal; if altered the contractions are diminished or abolished whatever may be the seat of lesion,—brain, spinal cord, or nerves.

But, however, pathology teaches us what are the conditions in which the nerves, and consequently the muscles, are altered; thus we know that this alteration is rare in cerebral paralysis, that it does not habitually occur in spinal paralysis; that it only does arise from disease of the multipolar cells of the anterior cornua of the cord; and that this alteration is *contrary* to the rule in paralysis relative to lesions of the grey matter, of the cord, and in paralysis of peripheral origin.

Owing to the knowledge of these facts we may presume to explore electrically the site of the cause of paralytic lesion.

In *cerebral paralysis* the electrical contractility remains normal, because the nerves and muscles remain normal. This proposition is applicable to all paralyses of recent cerebral origin, but in paralyses of old standing it is not applicable; for then the lesion causes a degeneration or a descending neuritis which reaches the nerves either directly or indirectly after having implicated the anterior cornua of the grey matter of the cord (lateral amyotrophic sclerosis).

In *spinal paralyses* the electro-muscular contractility remains intact if the lesion does not implicate the nerves or grey matter; if so then it is diminished and ultimately disappears.

In *peripheric paralyses* the electro-muscular contractility disappears from the commencement since the nerves and muscles are immediately or rapidly altered. There exists a remarkable difference between the currents of induction and continuous currents, relatively to their electro-motive power in peripheral paralysis.

Whilst *farado-muscular* contractility disappears in the first few days, the galvano-muscular (continuous currents) contractility often lasts to recovery (reaction of degeneration). This is often seen in paralysis from cold, but a satisfactory explanation has not yet been arrived at. What we know of this matter is resumed in the following table:—

Contractility.		Condition of Nerves and Muscle.	Paralyses.
Galvano-Muscular.	Farado-Muscular.		
Intact .	Intact .	Normal .	Recent cerebral paralysis; spinal paralysis (the columns only being implicated).
Abolished	Intact .	Altered .	Peripheral paralysis.
Intact .	Abolished	Altered .	Grave peripheral paralysis; spinal paralysis, with descending degeneration of the grey matter; cerebral paralysis, with descending degeneration.

Other nervous disorders—*hyperkineses*, *hyperæsthesiæ*, and *anæsthesiæ* have no practical semiological significance.

V. *Therapeutics.*

It is natural that it is in diseases of the nervous system that electricity is most employed, and it is in such cases that it produces its best results.

Motor Paralyses.—In the point of view of treatment, electricity ought to be considered as an *excitant* of the nervous system.

Therefore it is necessary that an excitant to be efficacious should act upon the organ the lesion of which is the cause of the paralysis; consequently it would be a vain hope to seek a cure of a paralysis of central origin by electrisation of the paralysed muscles. By this is it meant we are to infer that electrisation of the paralysed muscles is useless? Not by any means, for it prevents the muscular and nervous atrophy which is the result of prolonged functional inertia.

In paralysis of *cerebral* origin, electricity ought not to be employed except when all symptoms of irritation have passed. We apply continuous currents to the head in various ways. In paralysis of spinal origin it is also necessary to wait until the irritation has subsided, then to use continuous *ascending* currents, or currents of *induction.*

In *peripheral* paralyses electricity should be applied concurrently to the nerve and muscle, especially to the nerve. Continuous currents are preferable to act on the nerve, induced currents to act upon the muscle.

In *progressive muscular atrophy,* which without being a paralysis is nevertheless the effect of an alteration in the nervous system (spinal cord), in which case electrisation of the spinal cord gives better results than electrisation of the muscles (Benedikt). This was to be foreseen.

Hyperkineses.—The convulsive neuroses do not appear to be affected to any great extent by electricity. *Epilepsy* is refractory.

Chorea has been benefited and cured by its means, and the most remarkable fact in connection with the subject is that ascending or exciting currents have afforded the best results.

Legros and Onimus think that certain forms of chorea ought to be treated by excitants and others by hyperæsthesiants. In fact their opinion is borne out by Trousseau's treatment of chorea by strychnine.

(N.B.—The author has found more benefit derived in this disease from electricity, combined with the use of strychnine, brucine, or igasurine than any other mode of treatment.)

Legros and Onimus have recorded a case of *tetanus*, where a descending current combined with chloral led to a successful issue. Of course, the question arises whether electricity, without the chloral, would have led to the same result. In spasms, such as *Scrivener's palsy*, etc., electricity is not of much service.

In *locomotor ataxy or poliomyelitis posterior-chronica*, the ascending continuous current applied to the spine has occasionally ameliorated the disease, but never effected a cure.

Certain contractions often yield to electricity. Two methods of treatment are useful: 1stly, electrisation of antagonistic muscles for which induced currents are preferable ; 2ndly, electrisation of the contracted muscles, either with the object of exhausting their excitability, in which case induced currents should be used, or to act specially on the alteration of the nerves when a continuous current is preferable.

Anæsthesiæ.—Electrisation of the skin is of great service in anæsthesia of peripheral origin, especially in those cases due to slight alterations in the nerves.

According to Legros and Onimus, we ought to employ induction currents, or centripetal continuous currents. In hysterical anæsthesia, electricity gives rise to phenomena of transference.

Paralyses of sensorial nerves yield to electricity, if the pathological alterations are not serious.

Hyperæsthesiæ.—Electricity gives good results in all forms of neuralgia.

If the neuralgia be of central origin, it is necessary to electrise the centres; if it be peripheral, the electricity should be applied to the nerve cords. Induced currents, occasionally relieve the pain, but on account of fatigue and exhaustion of the nerve. Continuous centrifugal currents which diminish the excitability of the nerve, are preferable.

In muscular pains (lumbago, rheumatismal pains), faradisation has yielded good results.

Excitation of Inorganic Muscle.—The contraction of unstriped muscle is called for in various organs and under different circumstances.

Digestive Tube.—*Electrisation* of the stomach has been advised (1) in flatulent dyspepsia, (2) in constipation.

1. To electrise the stomach one electrode is applied to the spine, the other to the epigastrium.

2. To act in constipation one electrode is inserted into the rectum, the other is applied to the abdomen.

Urinary Tract.—*Paralysis of the bladder* is generally symptomatic of some medullary affection ; we ought then to electrise the spinal cord by ascending currents. But we may immediately relieve the retention of urine by electricity, one pole being applied to the spinal column, the other on the hypogastrium. Continuous currents are preferable (Legros and Onimus).

The *incontinence of urine* of children very frequently disappears by the use of continuous descending currents applied to the spine.

Legros and Onimus have obtained good results from electrisation of the spine by descending currents in *tenesmus of the bladder* and *spasm of the urethra.*

Genital Organs.—Some cases of impotency and spermatorrhœa have been successfully treated by electricity.

Electricity has often been employed to excite the contractions of the uterus in place of ergot of rye. One pole is applied to the lumbar region, the other to the hypogastric.

In amenorrhœa and dymenorrhœa the continuous descending current applied to the spine has often succeeded in restoring the menses.

In syncope and asphyxia, electrisation of the precordial region and the thoracic walls, one pole being applied to the nucha, the other to various parts of the thorax, is of great service.

The continuous ascending current ought to be employed, being less dangerous than induced currents to the heart, and more efficacious than descending currents for the restoration of respiration.

METALLO-THERAPEUTICS.

I PROPOSE to briefly resume in this chapter the results obtained in anæsthesia by the application of metallic plates. Burg, in France, was the first to call attention to the return of sensibility after these applications.

Physicians for a long time remained incredulous concerning the facts announced by this author, until, at his request, the Society of Biology, of Paris, appointed a commission consisting of Drs. Charcot, Dumontpallier, and Luys to study the question.

This commission presented two reports, one in 1877, the other in 1878, and their conclusions confirmed the results announced by Burg.

Since then metallo-therapeutics has attained the right to be cited as a science, and although many points remain to be elucidated, yet sufficient ground exists to have a defined idea of this branch of therapeutics.

Metallo-therapeutics acts principally through the following agents :—Metals, electricity, and magnets.

I. *Metals.*

Æstheseogenic action.—The principal action of metallo-therapeutics is to restore sensibility to the parts to which they have been applied.

We ought to study this action particularly, and it is in hysterical cases that we see this phenomenon in all its clearness. Take as a type a hysterical patient attacked with complete hemianæsthesia. The patient has lost tactile sensibility of the whole of one side of the body the sensibility of one half of the tongue, the senses of smell, of hearing; we observe also amblyopia accompanied by achromotopsia. If we apply to the anæsthesised limbs one or more plates of metal (copper for example), fixed by a band, we shall observe the following phenomena :—

At the end of some minutes (10—30) the patient experiences a feeling of heat, tingling, and discomfort at the edges of the plates, under each of which the skin is red, congested, and the tactile sensibility has reappeared at these spots, and for a certain variable distance beyond. Occasionally the application of a single plate suffices to restore sensibility to the whole limb or side.

If at the same time we examine the sound side we shall find zones of anæsthesia symmetrical to those in which sensibility has returned on the affected side. If sensibility has returned to the whole side the hemianæsthesia passes over to the other; this is termed the phenomenon of transference. This transference generally occurs, but not always. If the plates be removed the anæsthesia reappears on the affected side concurrently with the reappearance of sensibility on the sound side. But after repeated applications we may succeed in curing the patient. If we let the plates remain when the transference has taken place, that is to say, at the moment when the affected side is sensible and the sound side anæsthetic, we observe a second transference—oscillations between the two sides—until it remains stationary in its primary position.

To treat sensory anæsthesia it is necessary to apply the plates on or near the spot. Thus to restore gustative sensibility the metal is applied to half the tongue or to the neck; to restore smell the metal is applied to the ala of the nose.

To act on amblyopia and achromotopsia the metals are applied round the orbit, forehead, and temporal region. Oscillations of special sense occur in the same way as in general sensibility.

Aigre says that the complete cure of hysterical hemianæsthesia is rare.

Besides the above diseases, others have been tested by the same means. Charcot has published two observations of *post-hemiplegic-hemianæsthesia*, in which recovery was due to this means. In one of these cases two applications of thirty minutes each permanently restored sensibility; in the other one application sufficed; in the latter there was no phenomenon of transference.

Boussi has published the two following cases. C., after two attacks of right hemiplegia, was attacked with paralysis, with contraction of the forearm, and anæsthesia of the hand and arm—recovery. M. J., Paralysed in the right forearm accompanied by anæsthesia—probable cause cold—on the 2nd of May: two gold plates applied to forearm, the 6th of May—cure which lasted.

We see in these two cases not only cure of the anæsthesia, but of motor paralysis also.

Up till now we have supposed that any metal is capable of effecting the return of sensibility in anæsthesia, but this is not the fact, for experience has demonstrated, that each patient is only sensible to some particular metal. On a given patient iron will have no action, and sensibility will only return with gold, silver, lead, copper, or tin. Therefore, if no result be obtained with one metal, it will be necessary to essay another. It is rare, however, that a patient is sensible to one metal alone. To recognise this sensibility to metals we successively apply different plates of metals to various parts of the body which are the seats of anæsthesia; after ten or twenty minutes of application of each of them, we explore the state of sensibility at their edges.

A curious phenomenon has been observed by Burg, and verified by Charcot and Vigouroux.

If in an anæsthetic patient, in whom you know sensibility to be restored by gold, you place a plate of silver over the gold one, no modification of the anæsthesia will occur; lift up the silver plate and sensibility will return. This same phenomenon occurs if the plates are placed at a short distance from each other.

Experiments made with other metals have given the same result.

Thus the simultaneous employment or the superposition of two different metals hinders the æsthesiogenitic action of the metals. The following is a curious fact discovered by Dumontpallier. Having applied four plates of gold on the forearm of a hysterical patient *who presented no trace of anæsthesia*, he found that the skin covered by the plates had become completely insensible. The sensibility returned when the plates were removed. The same experiments made with iron and silver gave no results. Metals, therefore, can exercise no anæsthetic influence on hysterical patients.

II. *Electricity.*

We are already acquainted with the action of electricity on sensibility. It is, therefore, sufficient to say that electricity, whether dynamic or static, produces exactly the same effect as metals. The observations of Vigouroux, Magnan, and Debone demonstrate cases of anæsthesia that have been cured by its means. In several cases phenomena of transference have been observed. (See "Theory of Metallo-Therapeutics.")

III. *Magnets.*

On the application of magnets we observe all the phenomena observed on the application of metal plates. Vigouroux has published a successful case of contraction and hysterical anæsthesia treated in this manner. Debone and Aigre each report successful cases of post-hemiplegic anæsthesia.

It is remarkable that those cases, not amenable to metals, are frequently cured by magnets. The mode of application of magnets is the same as that of metallic plates.

Proust and Ballet have observed the following curious facts in connection with magnets. If you apply the hand of one hemianæsthetic patient to that of another, the hemianæsthesia disappears in both. This disappearance of the hemianæsthesia from the second is not due to the distant action of the magnet, for it does not take place if the patients simply unclasp their hands. The body of the first patient acts as a conductor of the magnetic current to the second.

THEORY OF METALLO-THERAPEUTICS.

The identity of the phenomena produced by plates of metal and magnets, with those produced by electricity would lead us to suppose that electricity was the only agent, and that all the observed phenomena are to be attributed to it. Bourneville and Regnard, having experimented on this subject, have established the following points:—The application of metals gives rise to feeble currents of electricity, varying in intensity with each metal.

We may, therefore, formulate this question: Knowing the electro-motive force of a metal, is it possible to obtain by currents of the same intensity, furnished by a battery, results similar to those obtained by the application of plates?

Experiments made with the view of answering this question allow us to affirm that these currents do restore sensibility to anæsthetic patients. Thus gold yields currents of 2°—12° deflection of the galvanometer of Dubois-Reymond; if the patient be sensible to gold, a battery current of 2°—12° produces the same result.

For other metals other currents of corresponding intensity are required. Thus the fact is established that metallic plates act by producing electricity.

How is this electricity developed?

According to Onimus, it arises from the chemical action of the metal and the skin. Vigouroux combats this opinion and supports his view from the point that when two metal plates are superposed that the chemical action is not modified while the general effect is hindered. I cannot agree on this point as the juxtaposition of two metals would give rise to an extra current of such electromotive force as would reduce the primary current to below the standard of intensity required to produce the general physiological effect; in fact, that when a battery current is employed just sufficient to act say from 2°—12° deflection, and we reduce it to 1°, we must not be surprised if we do not get any result.