

may fall asleep at once on retiring to rest; but, after one, two, three, or four hours, he awakes, and then he either lies awake for hours, or he is constantly falling asleep, dreaming, or having the nightmare, and awaking—four or five times or even oftener in the course of an hour—until the morning comes, when he drops into a quiet sleep of an hour or more, or he is obliged to get up tired and irritable. This sleeplessness, like the vertigo we have already considered, is often induced by particular articles of diet, or by some unwholesome combination of them. What will excite headache, giddiness, or disorders of the circulation in some patients will in another cause sleeplessness. Sometimes, however, this symptom will occur when the patient is most careful as to diet. What is important also to note is, that, in most of these cases, there are no obvious symptoms of gastric dyspepsia; the appetite may be good—too good in fact; the bowels may be irregular; and there may be no pain, flatulence, or other discomfort after meals; but there will be found an unusual tendency to the deposit of lithates in the urine, and very often other phenomena of a so-called gouty diathesis. This form of sleeplessness was described a century ago by Cullen, the distinguished nosologist, in these words: "Persons who labour under a weakness of the stomach, as I have done for a great number of years past, know that certain foods, without their being conscious of it, prevent sleeping. So I have been awakened a hundred times at 2 o'clock in the morning, when I did not feel any particular impression; but I knew that I had been awakened by an irregular operation in that organ, and I have then recollected what I took at dinner, which was the cause of it. Dr. Haller is liable to the same complaint; and, in his larger work especially, he gives the particulars of his own case."* The affection has also been well described by Dr. Dyce Duckworth in some excellent observations on different forms of sleeplessness recently published.† It is, however, a form of sleeplessness not generally understood, and harm is often done to patients suffering from it by the administration of opiates and other soporifics, from ignorance of its real cause. Very often the symptom will be greatly relieved, if not entirely removed, by careful attention to diet, and particularly by moderation in, or abstinence from, wine; and, in some cases, a dose of carbonate of soda when the patient goes to bed, or when he first awakes, is of service. Some patients with this form of sleeplessness have told me that they never sleep so well as after a dose of calomel or blue pill.

10. *Depression of spirits.*—The influence of the liver upon the animal spirits has been recognised by medical writers in all ages. To the belief in the existence of such an influence may be traced the origin of such terms as *hypochondriasis* and *melancholia*. Although it is not contended that the morbid states of mind to which at the present day we apply these terms have their origin in the liver, they are unquestionably, in many instances, accompanied and aggravated by derangements of this organ; and it is equally true that, independently of either hypochondriasis or melancholia, persons with functional derangement or structural disease of the liver are subject to fits of great depression of spirits and often groundless fears of impending danger, which cease when the liver is restored to its normal state.

11. *Irritability of temper* is another common symptom of functional derangement of the liver, and is sometimes the first indication of anything wrong. A man who has previously borne the crosses of life with equanimity, and been amiable to those about him, gradually becomes disconcerted by trifles; his mind broods upon them; and he makes all around him unhappy, and himself the most miserable of all. His relatives, perceiving no other sign of indisposition, and failing to recognise the true cause, too often put down the ebullitions of temper to something mentally or morally wrong; but remedial measures calculated to restore the liver to healthy action, if resorted to in time, will often remove the irritability, and thus reveal its cause.

12. *Cerebral symptoms and the typhoid state.*—It is well known that restlessness, delirium, stupor, coma, subsultus, tremors, convulsions, a dry brown tongue, and other phenomena of the "typhoid state," are apt to supervene in certain cases of advanced disease of the liver, whether attended by jaundice or not. These symptoms have been

usually attributed to a suppressed secretion of bile. But the assumption that the elements of the bile are performed in the blood, and are merely separated from the blood by the liver, we have already found to be devoid of foundation, and we have also found that bile is far from being, as commonly supposed, a deadly poison, and that its presence in the blood, even to saturation, does not give rise to cerebral symptoms. The cerebral symptoms referred to are often most severe when the jaundice is slight, or when there is none, and they are readily accounted for by the knowledge of the disintegrating function which the liver is now known to perform. When this function of the liver is arrested or seriously impaired, urea is no longer eliminated in sufficient quantity by the kidneys; lithic acid and deleterious products of disintegrating albumen even less oxidised, such as leucin and tyrosin, and perhaps others with which we are as yet imperfectly acquainted, accumulate in the blood and tissues, and the result is the development of symptoms of blood-poisoning similar to those which arise when the kidneys are unable to eliminate the products of albumen-disintegration owing to disease of their own structure, or to an excessive formation of urea and other products, as happens in many febrile diseases. In acute atrophy, for example, the structure of the liver is destroyed and its functions arrested; leucin and tyrosin take the place of urea in the urine, and are also found in large quantities in the liver, spleen, and kidneys, while cerebral symptoms and the typhoid state are prominent features of the disease.

ABSTRACT OF

Lectures ON

ELECTRO-THERAPEUTICS.

Delivered at Charing-cross Hospital,

By G. VIVIAN POORE, M.D.,

ASSISTANT-PHYSICIAN TO THE HOSPITAL, ETC.

LECTURE II.

PRINCIPLES INVOLVED IN THE CONSTRUCTION OF INDUCTION APPARATUS.—GENERAL CONSIDERATIONS WITH REGARD TO BATTERIES AND INDUCTION COILS.

INDUCTION is of two kinds—voltaic and magnetic. The principle of voltaic induction is simply this, that conductors traversed by voltaic currents induce electric disturbance in neighbouring conductors. A voltaic induction apparatus consists of a galvanic element and two coils of wire, one of which is freely movable over the other. The internal coil is fixed; it contains a core of iron wires in its interior, and its two ends are attached to the poles of the galvanic element, of which it forms the circuit. The outer movable coil has no communication whatever with the galvanic element. By a simple contrivance a patient or any part of a patient can be included in the circuit of either coil. Now whenever the circuit of the primary coil is opened or closed a momentary current traverses the spirals of the outer coil. This current which is induced in the outer coil flows in an opposite direction to the inducing current when the circuit is closed, and in the same direction as the inducing current when the circuit is opened. The opening current is therefore more powerful than the closing current. Since these induced currents are of only momentary existence—at the instant of making or breaking the current in the inducing coil,—some means of rapidly making and breaking the inducing current is necessary. This is effected by means of the core of soft iron wires, which becomes strongly magnetic whenever an electric current traverses the coil which encloses it. Over the core is a spring hammer, the head of which is attracted whenever the core becomes magnetic. The shaft of the hammer is so constructed that it is an integral part of the conductor; and whenever the head of the hammer is attracted by the iron core, the continuity of the conductor is broken, and the current is interrupted. The current ceasing, the core is no longer magnetic, the hammer flies back to its original position, and the current, and with it

* Institutions of Medicine, 1770.

† British Medical Journal, December 27th, 1873.

the magnetism, is instantly renewed, to be as instantly interrupted again. In this way a succession of induced currents is insured in the outer coil.

Again, whenever a magnet is inserted into, or withdrawn from, the interior of a coil of wire, an electric current is induced in the spirals of the coil. When, therefore, the core of iron wire becomes magnetic by the inductive action of the electric current circulating in the coil, the core in its turn induces an electric current in the coil surrounding it. Further, each turn of the coil has an inductive action on the turns next it. Thus in an induction apparatus we have two induced currents: (1) the current induced in the external coil, which is spoken of as the *induced current*, or the *current of the secondary coil*; (2) the current of the internal coil, partly due to voltaic and partly to magnetic induction. This is spoken of as the *extra current*, or the *current of the primary coil*.

The strength of the current of the secondary coil is regulated by the degree in which it overlaps the primary coil. When the overlapping is complete the current is at its maximum, and when the inner coil is in no degree overlapped by the outer the current ceases.

The current of the primary coil is regulated by a brass sheath, which can be drawn completely, or to a less degree, over it. This brass sheath has the effect of counteracting and annulling the inductive action of the soft iron core, and the intensity of the "extra current" is therefore in exact proportion to the amount of the coil which is not enveloped by the brass sheath.

The ordinary magneto-induction apparatus consists of two coils of insulated copper wire, wound round cores of soft iron. These coils can be made to rotate rapidly round each other, so that their soft iron cores are brought alternately in contact first with one and then with the other of the poles of a stationary horseshoe magnet. The soft iron cores coming in momentary contact with the poles of the magnet are themselves induced with momentary magnetic properties, on the accession and cessation of which electric currents are induced in the coils which surround them.

There are certain indispensable qualities and accessories which all medical batteries should possess. These are—

1. *Constant elements*.—The medical practitioner has at present a large choice of serviceable elements. The modified Daniell's, the modified Smee's, the Leclanché, and the Stöhrer element, are all reliable.

2. *A large number of elements*.—This follows as an obvious result of Ohm's law, for when dealing with the human body the resistance in circuit becomes very great, and consequently a large number of elements is absolutely necessary. "The electro-therapist," says M. Cyon, "will not obtain a stronger current with forty elements as big as a tumbler than with the same number the size of a sewing thimble." Another advantage of having a large number of elements is that, as those which have been most used become weaker, we may have some to fall back upon which still retain their power.

3. *The elements should be capable of being immersed in or lifted out of the exciting liquid at pleasure*.—Since it is almost impossible to prevent local action, even when the circuit is not closed, this becomes a most important consideration. *Cæteris paribus*, those batteries are to be preferred in which it is impossible to close the lid unless the elements are free of the liquid. With Daniell's elements the matter of liberation from the liquid is of less importance, since these, as well as the Leclanché elements, will remain in working order for many months, even though they be constantly immersed.

4. *Means of regulating the intensity of the current*.—This is usually effected by bringing a greater or less number of elements into the circuit. It may also be effected by introducing varying amounts of artificial resistance into the circuit by means of instruments called rheostats. Duchenne has been in the habit of regulating the intensity of his currents by a rheostat consisting of a column of water, a greater or less length of which can be included in the circuit. For more accurate purposes the rheostats known as Siemen's, or Meyer and Wolff's, are necessary, by means of which known lengths of wire, offering a definite resistance, can be included in the circuit. For all ordinary clinical purposes rheostats are not required, and the regulators, by means of which a greater or lesser number of elements are employed, are all that is necessary.

5. *Means of opening and closing the circuit and of controlling the direction of the current*—in other words, a key and commutator—are absolutely necessary, and no battery can be considered as complete which is not furnished with this apparatus. By means of it we are enabled to open and close the circuit and reverse the direction of the current without altering the position of the rheophores on the patient's body. Another accessory of some importance is a *rheotome* or interrupter of the current. Slow interruptions may be effected by means of the commutator, but for rapid interruptions a cogged wheel is required. The pedal rheotome and commutator designed by Dr. Gowers will be found a very useful piece of apparatus.

With regard to induction apparatus, these should have,—

1. *Well insulated coils*.—When buying an induction machine, always look to this point, and see that the wires are carefully "served" with their silk covering. The surface of the coils should be covered with a layer of varnish, and the regulating tube should slide over the primary coil without any undue amount of friction, which would rapidly cause the rubbing off of the insulating material.

2. *Means of including in the circuit either the primary or secondary coil without altering the connexions of the conductors*.

3. *Means of regulating the interruptions of the primary current*.—This should be effected automatically by means of the magnetic core and the spring trembler. The interrupter supplied with Stöhrer's apparatus is almost the only automatic one which allows of any exact regulation of the rapidity of interruption.

4. *Means of graduating the intensity of either current*.—This is effected by (a) the degree of immersion of the elements; (b) the "extra current" is regulated by the brass sheath which slides over the primary coil; (c) the induced current is regulated by the position of the secondary coil with regard to the primary coil.

In the magneto-induction apparatus the rapidity of interruption is regulated by the rapidity of rotation, and the intensity of the current by the position of the armature with regard to the poles of the horseshoe magnet. These magneto-induction apparatus are very cheap, and little liable to get out of order; and if they could be so made that the rotation might be effected by means of a treadle, and thus leave the hands of the operator at liberty, there is no reason why they should not be employed on most of the occasions where faradism is indicated. Batteries and induction apparatus should both be furnished with good conductors. The most generally useful form of conductor is ordinary gutta-percha-covered telegraph wire. This form of conductor, being very perfectly insulated, is very effectual, and, being impervious to moisture, is little liable to get out of order. The only advantage of the ordinary silk-covered conductors is their greater pliancy; but otherwise they are less perfect conductors, more expensive, and far less durable than the telegraph wire. The telegraph wire allows us by the exercise of a little ingenuity to make our own connexions, which is often a very great advantage.

When buying a battery, always see that the elements are covered so that no dust can fall into the cells. If dust fall into the cells we are liable to get local action, sulphurous fumes, and weakening of the exciting liquid. Cleanliness is of the greatest importance. Always see that a battery is clean and dry before putting it away.

It is very advisable to become thoroughly acquainted with the construction of apparatus, and the possessor should, once at least, take them to pieces and put them together again. In this way more knowledge is got than by any amount of reading; and in case of any failure on the part of the apparatus, one is enabled intelligently to investigate the cause.

It is much to be regretted that manufacturers are not agreed as to the best form of binding screw and connexion. They all have their own, and, as a consequence, the apparatus of one manufacturer cannot, as a rule, be used with a battery made by a different manufacturer. Thus a great check is placed upon the sale of electrical apparatus for medical purposes. Even the same manufacturer will occasionally employ a different form of connexion for his galvanic and his faradaic apparatus, apparently for no reason at all. Here, for example, are two galvanic batteries and one induction apparatus made by the same manufacturer. The rheophores supplied with the batteries cannot be properly affixed to the induction apparatus owing to the difference in the

form of connexion, and thus one is put to the needless expense of having special rheophores for each apparatus. Again, the commutator and interruptor, which is readily attached to one of the galvanic batteries, cannot, by the exercise of any amount of ingenuity, be affixed to the other. Manufacturers will best serve their own interests by attention to details of this kind.

ON THE REMOVAL OF HÆMORRHOIDAL AND OTHER TUMOURS.

BY HENRY LEE, F.R.C.S.,
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DUPUYTREN and Cline were in the habit of removing internal piles by cutting them off with a pair of scissors. Sir B. Brodie at one time adopted this practice. In about two-fifths of Dupuytren's cases subsequent hæmorrhage occurred, and sometimes to a very considerable extent. Sir B. Brodie, during the short time he tried the practice, states that, in the first one or two cases, he found no inconvenience to arise from his altered practice; but then a case occurred in which the patient lost a great deal of blood; in another case the hæmorrhage was so great that the patient nearly died; and then a third case occurred in which also the patient lost an enormous quantity of blood. After that time Sir B. Brodie always removed large internal piles by ligature. The following is the plan he recommended:—If the piles be of large size a large curved needle is passed through the base of each, armed with a strong double ligature. The double ligature is divided into two single ligatures, "which are tied round the base of the pile, one on one side and the other on the other side, with a single knot. . . . You then proceed to another step of the operation: cut off the convex portion of each pile, so as to make an opening into the cavity of the convoluted vein which forms it. Thus you take off the tension produced in the pile by the blood which it contains, and are enabled to draw the ligature tighter than before. . . . You have now only to complete the double knot upon each of the ligatures, and cut off the threads close to the knots, returning the piles, ligature, and all into the rectum."

Now in this mode of performing the operation there is one source of danger which has been overlooked. It may so happen that a large vein is transfixed by the needle, and its two sides held separate. Its open mouth would then be bathed in the puriform secretions of the parts, and the conditions would be those most favourable for the absorption of those secretions. I have examined the body in more than one case where death might have been attributed to this cause. In one instance in particular, where the operation was performed by a most experienced surgeon, secondary deposits were found in the liver and in no other part—showing that the absorption must have taken place through the superior hæmorrhoidal veins. This particular cause of danger may be avoided by carrying the ligature from one side, after the double knot is tied, round the whole tumour, as has often been done, and tying it on the opposite side.

Another objection to this mode of operating is the pain. In order to draw the ligatures very tight, the parts must be pulled down to a level with the hands. This causes very considerable suffering; and although, for the moment, or under the influence of chloroform, this may be of no great consequence, yet there can be no doubt that the less the parts are disturbed the less risk there will be of subsequent inflammation. I have known a number of patients who have complained most bitterly of the pain that has been caused by the operation of tying their piles, and this not only at the time or immediately after the operation, but sometimes for several days. This pain I have attributed in great measure to the forcible dragging down of the parts below the level to which they would naturally be protruded.

A third objection to the operation by ligature is the comparative length of time that the patient is kept in bed. The ligature has to eat its way through, and some portion of the pile necessarily sloughs off before the process of re-

pair can commence; a week may thus be lost, during which time generally there is more or less constitutional disturbance.

The old operation which I have now described was, on the whole, a good one and generally successful, but patients who have undergone it have often warned others against undergoing the same. Some patients have an instinctive dread of having any cutting or of having needles used. The operation may then be performed with safety and without dragging upon the parts by the elastic ligature. I have performed several operations in this way. The pile is seized with a pair of forceps which closes with a spring or a screw and terminates in a ring. The elastic ligature is carried with the point of the finger several times round the end of the forceps and tied. The protruding pile or piles are then returned into the rectum. They slough off in the same manner as if tied with a silk ligature, but there is this additional security—namely, that the ligature always remains tight. If the pile be large, and a ligature is applied, after it has eaten its way partly through it becomes loose, and should the pile not be completely dead the circulation in it may be in part restored, and there is some danger of the products of the decomposing mass becoming absorbed.

It is astonishing with what rapidity the elastic ligature will cut its way through. Not long ago a case of fistula in ano was under my care in St. George's Hospital. Not wishing, for some cause or other, to perform the usual operation, I passed several threads of elastic ligature through the fistula, and brought them out of the rectum. They were then tied moderately tight. At the expiration of forty-eight hours I was going to farther tighten the ligatures should it be found necessary, when, to my surprise, they came away in my hand, having completely divided all the structures between the fistula and the bowel. The elastic ligature, if used for this or for other purposes, should be solid. If tubular, when stretched it flattens against the parts, and, consequently, does not cut through them so easily.

The objections mentioned with regard to Dupuytren's and Brodie's modes of removing piles apply in some degree to a modified operation which has been extensively practised of late years. It consists in a combination of cutting and tying. The tumour to be removed is drawn down by a hook armed with several sharp teeth. The mucous membrane is cut through at its sides and lower part with a pair of scissors. The remainder of the pile, which generally contains its arterial supply, is then tied. The portion of the tumour which projects beyond the ligature is cut off, and the remainder is returned into the rectum.

By far the best and safest way, according to my experience, of removing a pile, is to grasp it at its base with a clamp made in the shape of a pair of scissors, curved on the flat, and with the points turned inward; then to cut the pile off with a pair of scissors of the same shape, and to sear the cut surface with an iron after it has passed from a dull-red to a black heat.

The advantages of the clamp represented in the accompanying electrotpe are: 1. That, being curved horizontally, it can be inserted between the nates, so as to grasp the base of the pile, without the latter being forcibly dragged down. 2. From the limbs of the instrument being curved inward, every portion of the pile is equally compressed, and no part can possibly slip. 3. One blade is made to play within the other, so that they cannot be displaced by any horizontal pressure. 4. The blades are sufficiently thin to allow nearly the whole even of a small tumour to project, and consequently to be removed, on the concave surface of the clamp.

Operating with this instrument, I have hitherto had no case in which there was any hæmorrhage to signify. About a year ago I removed a large portion of the tongue with a similar instrument; and about a month from the time I am writing I removed a testicle affected with soft cancer, which weighed something less than a pound. The cord was seized with the clamp and cut with a pair of curved scissors. The cut surface was then seared in the way described. No ligatures were required. The wound was closed with carbolised sutures, and healed very satisfactorily, although the patient had an attack of erysipelas of the skin covering some enlarged glands in the opposite groin.

The first curved screw clamp which I had made was in