with considerable improvement in the general condition. Four years later, however, she had an attack of acute tonsillitis, which was followed by a recurrence of the rheumatism. Removal of her tonsils has resulted in improvement in her general condition and rheumatic symptoms.

4. Multiple Foci.—The occurrence of multiple infective foci presents a somewhat similar difficulty. Having discovered one focus, the surgeon is apt to rest content and thereby miss another, and possibly more responsible, one. An excellent example of this mistake can be shown by the case of a woman, aged 42, who, fifteen years ago, was affected with septic arthritis of relatively sudden onset. This was presumed to be associated with infected teeth, and these were dealt with, with perhaps some degree of improvement, but the patient remained more or less an invalid. The occurrence of an otitis media two years ago led, as a routine, to the examination of the nose. To my surprise I found on transillumination that the antrum on one side was completely opaque. Operation disclosed chronic disease in the antrum, which from its nature had almost certainly resulted from the original dental infection many years previously. A recent note of her condition states that she is now fit. Some deformity of the joints remains, but there is no sign of any active disease.

To sum up, I hope that to-day's discussion may do something towards the consolidation of our ideas as to the scope of focal infection and as to the way in which the difficulties of its application to clinical practice may be surmounted.

ELECTROTHERAPY IN THE TREATMENT OF DISEASES OF THE GENITO- URINARY SYSTEM*

BY

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Owing to the fundamental character of its action electricity, in one of its many forms, has proved itself of value in a very large number of diseased conditions. If, however, as Dr. Golding Bird¹ wrote in 1847, when dealing with electrotherapy, we wish to act as "scientific and philosophic physicians," we must inquire into the "rationale of the process" which we employ. It is not sufficient merely to enumerate the various diseases which may be beneficially treated by electricity, or to allege a number of cures. There will be no advance in our methods, and none of our scientific brethren will be convinced, if we lay down an empirical classification of our remedies, baldly stating that "zinc ionization" is good for endometritis, or that diathermy is indicated for the relief of dysmenorrhoea. Such mere assertions will carry no conviction.

On the other hand, if we expound the "rationale of the process" which we employ—namely, that the septic membrane in endometritis can be thoroughly and completely destroyed by the electro-chemical process which ensues from the electro-deposition of a caustic-forming ion, such as zinc, upon the interior of the uterus—we afford an explanation of the "rationale" of our method—which is deserving of the consideration of all open-minded physicians. Or, if we point out how the relaxation of spasm and tension in dysmenorrhoea can be effected by the deep heat generated by the diathermic current, and how the vibratory process, which is the precursor and

generator of this thermal action, further serves by its dispersive action to relieve tension and pressure, then we may obtain a rational appreciation of electrotherapy from all except those whose complete ignorance of electrical methods is only equalled by their reluctance to learn anything about them. It is on such broad principles that I propose to open this discussion.

The main forms of electrical current employed in electrotherapy are: (1) the constant or galvanic current; (2) the interrupted currents of low frequency; and (3) the interrupted currents of high frequency.

Local Application of the Constant Current

In its general application the constant current owes its main effects to the reflex action induced by the stimulation of the skin nerve endings by the electro-deposition of various ions. In this form it is not of great importance to the subject of the present discussion. In its local or polar application, on the other hand, it is one of the most valuable remedies at our disposal. In the treatment of endometritis by the constant current we introduce a zinc rod or uterine sound within the uterus, and connect it with the positive pole of the source of supply. The zinc cations proceeding from this zinc rod carry the positive charge down to the mucous membrane of the uterus, at which point, owing to a change of liquid, another set of ions, mainly the hydrogen ions of the tissues and blood, continues the convection. The mucous membrane thus forms a virtual pole at which the zinc ion, yielding up its positive charge, forms with the oxygen and chlorine of the tissues an oxychloride of zinc, and, by the chemical decomposition involved in the formation of this salt and by its subsequent caustic action, the membrane is thoroughly and intimately destroyed. Provided the indifferent electrode and pad surrounds the whole circumference of the abdomen, the destruction takes place over the whole inner surface of the uterus, and so evenly is the destructive process distributed that the destroyed membrane may be subsequently passed as a complete cast of the interior of the uterus.

The application lasts for about fifteen or twenty minutes, towards the end of which uterine contractions, appreciated as pain, may be excited; these are an indication to cease the treatment. If the application causes any pain in its early stages it is evidence of complications in the appendages, such as pyosalpinx, and further treatment should be discontinued, since these cases are unsuitable for this method. It is interesting to recall that Apostoli employed the method to ascertain the condition of the uterine appendages. According to him, if the large current of 100 to 150 mA was tolerated the appendages were above suspicion. If a current of 50 mA excited pain the appendages were open to suspicion. Intolerance of 30 mA indicated serious trouble in the tubes, and if there was intolerance of 20 mA the uterine annexes should be removed.

From what, in current parlance, may be termed a fifty-fifty experience of curetting and zinc electro-deposition, I have no hesitation in pronouncing in favour of the latter method, except in cases from which placenta remains have to be removed or scrapings obtained for pathological examination. Zinc electro-deposition entails little inconvenience, and no nursing home, anaesthetic, or lying up. The apparatus required is of the simplest kind, the best battery for the purpose, complete with water resistance, costing less than 5s. There is no better, no less expensive, and no more convincing method with which the general practitioner can begin electrotherapy. A similar method of treating gonorrhoea by zinc electro-deposition was introduced by Bouchet in 1907. He employed a zinc wire within a perforated rubber catheter, through which a solution of 1 or 2 per cent. solution of zinc sulphate

* Read in opening a discussion in the Section of Radiology and Electrotherapeutics at the Annual Meeting of the British Medical Association, Bournemouth, 1934.

was irrigated. A similar method has been used with success for the treatment of otitis media, and many other conditions.

The history of electrotherapy shows us that one of the many and great disadvantages attending the lack of any systematic teaching of our science, and consequent upon its non-inclusion in the schedules of the examining boards, is that older and more valuable methods are often lost sight of owing to the glamour that accompanies the introduction of a hitherto unknown method of treatment. There is no doubt that the benefits of electro-deposition do not to-day receive the recognition they deserve.

Interrupted Currents of Low Frequency

While these currents are certainly among the most valuable and the most frequently indicated in other diseased conditions, they are of relatively little use in the treatment of genito-urinary disease. The method of the graduated electrical excitation of muscle by the faradic coil, which we owe to Sir Morton Smart and Mr. Rowley Bristow, is of great value in the restoration of tone to the abdominal muscles, and so indirectly aids in the relief of uterine malposition. The faradic coil is also of considerable benefit in the treatment of many cases of incontinence of urine in the male, and to a less extent in the female.

The Morton wave current, a unidirectional, interrupted current of low frequency, is often indicated in the treatment of the prostate, but I need say little in reference to this, since it will be dealt with fully by Dr. Howard Humphris, who has had far more experience in this than I have; it was, indeed, to Dr. Humphris that I owed my first introduction to this valuable instrument, the static machine. The very high voltage obtainable from this instrument—about 60,000 volts—and the very abrupt break of the current by spark discharge, yields a density of current which most thoroughly pervades the muscle or organ treated, and excites more powerful muscular contractions with less discomfort than any other method. Compare for a moment the effect obtained in this way, in the treatment of the prostate, with digital pressure on that organ per rectum. For cleanliness, convenience, and, above all, for efficiency, it must be evident that a method which enables us to produce alternate contraction and relaxation of the whole gland must be incomparably preferable to the remote kneading of its posterior surface by digital pressure. Among the most convincing proofs of the efficiency of this technique are the permanent cures which result from the treatment of those painful conditions of prostatitis which often follow old-standing cases of gonorrhoea.

Interrupted Currents of High Frequency

The interrupted currents of high frequency are a very valuable group in the treatment of diseases of the genito-urinary system. The paramount question in relation to the therapeutic action of these currents is whether their effects are due to heat alone, or whether they are, in part at least, due to the vibratory or oscillating action of the ions which precedes and produces this heat. I ventured to raise this point eleven years ago at the Portsmouth meeting in 1923, and the view then expressed was that this question should not be raised, as medical men were just beginning to appreciate the beneficial effects of diathermic heat, and their minds should not be confused by the possibility of these currents possessing any additional action. It is clear that this question cannot be dismissed in this summary fashion. On purely *a priori* grounds it would appear evident that a current of the high voltage employed, oscillating at a frequency of 1,000,000 to 30,000,000 times a second, must produce

effects other than the heat generated by the ionic collision at such a frequency and voltage.

Arguing from analogy, we recognize that the vibration of modern motor traffic is injurious to our old buildings. In this case it is not merely the weight of the vehicles that is the cause of the trouble, for we have had the slow-moving, but very heavy, traction engines for years past without any serious vibration damage resulting. The modern damage has resulted from a certain ratio between speed and weight, analogous to frequency and voltage. And it is possibly from the fast travelling and heavy motor buses that much of the damage has resulted. Passing from the coarser to the finer vibrations, we have the molecular disintegration, occasioned by the electromagnetic stresses, which takes place in the wire winding of our Oudin resonators—that is to say, if such resonators are wound with brass instead of phosphor bronze wire, the brass wire becomes so disintegrated in its structure, and so soft and friable, that a length of about six inches, when held horizontally, has insufficient cohesion of structure to support its own weight.

In the experiments of Wood and Loumis on supersonic waves of high frequency and high voltage, generated by a piezo-electric generator of quartz, we find a very striking example of the extraordinarily powerful "pounding" action of these supersonic vibrations. The voltage employed in these experiments was very high—50,000 volts—and the oscillations were 300,000 per second. In general outline the generator was of the triode valve type. Blood blisters, persisting for several weeks, were formed by the pounding transverse vibrations on the fingers holding a glass rod, the end of which was dipped in the transformer oil in which the vibrations were occurring. Small fish and frogs were quickly killed. "Filaments of living spirogyra were torn to pieces and the cells ruptured." Blood corpuscles were broken up by the molecular oscillations set in motion by these pounding vibrations.

D'Arsonval and Charrin found that the toxicity of a very active diphtheria toxin was destroyed by exposure to high frequency for fifteen minutes, although the temperature of the media or their contents never exceeded 98.5° F. Clinically, when administering diathermy, I have noticed the disappearance of a bruise exactly corresponding in its limits of disappearance to the area of the electrode. If this disappearance of the ecchymosis was due to heat the limits of its disappearance would be more diffused. The rapid subsidence of swelling in the treatment by diathermy of a recent injury, such as a Colles's fracture or a sprained ankle, is more rapid than can be accounted for as the effect of heat alone. It has been alleged that these disappearances of ecchymosis and swelling are due to the pressure exercised by the bandages which secure the electrodes in place, but I have noticed a similar disappearance, both of swelling and of ecchymosis, when treating a sprained ankle by a 30-metre wave-length. In this case the electrodes were not bandaged on but merely supported in position by lateral sandbags, and were only in contact with the ankle at the malleoli; the disappearances corresponded exactly in their limits with the high-frequency electro-magnetic field.

Bordier obtained very similar results to those of Wood and Loumis, although he utilized a frequency of 30,000,000 at a far lower voltage than they did. Thus there would seem to be an optimum wave-length of very high frequency at which these disruptive and dispersive results can be obtained. Now this is a point of great importance and interest when dealing with the short and ultra-short wave-lengths which are now beginning to excite so much attention. It would appear, I think, that there is not a specific wave-length at which any particular micro-organism can be destroyed, but rather an optimum

wave-length at which the organism can be destroyed at a minimum voltage, though at a longer wave-length an increased voltage would produce a similar effect.

Some fifteen or twenty years ago I was one of the first to treat dysmenorrhoea by diathermy. I was led to do so by the remark of a patient whom I was treating by diathermy for pelvic pain, unassociated with the menstrual period, to the effect that after her last period she had had the first period free from pain for fifteen years. I adopted this useful hint, and have learned the great value of this treatment in suitable cases of spasmodic dysmenorrhoea. It is, indeed, easy to visualize that the spasm tends to be relieved by the thermal effects of the high-frequency currents, and that dispersal of the engorgement is aided by the vibrations; the value of these united actions in the treatment of such distressing conditions is thus readily appreciated. I believe that the short or ultra-short wave high-frequency currents will prove to be of special value in these cases. Space will not allow me to deal fully with their advantages, but it must be evident that a technique which does not necessitate the removal of any clothing is in itself a great advance. This, however, is only a matter of convenience, and the specific value of the short-wave currents will be found to be due perhaps to some extent to their more rapid and finer vibrations, but chiefly to their more even concentration and action within the body. The long-wave diathermy of about 300 metres enters the body mainly by conduction, partly by condenser or leaky condenser effect through the skin, and in a few types of application by a condenser field action. Consequently, with such wave-lengths, the conductivity of the tissues influences to some extent the effect of the treatment. The short waves, on the other hand, excite their effects solely by a condenser field action; no current actually passing through the skin, the oscillations are excited solely within the body, and as a result the tissues and structures of the body react more evenly and uniformly. It is upon such lines that I venture to open this discussion and to explain the rationale of our processes; in this manner we travel along a path, parallel to that along which physical science is to-day advancing, towards a goal of as great efficiency and exactitude as has as yet been reached by any branch of medical science.

REFERENCE

¹ Golding Bird: *Lectures on Electricity and Galvanism*, 1849.

Census of England and Wales, 1931: Occupation Tables is now on sale at H.M. Stationery Office, price 30s. net. In addition to the statistics for the country as a whole, data are furnished in similar detail of occupational subdivision for twelve geographical regions into which England and Wales has been divided, and also for counties and large urban areas. For the smaller urban areas and for rural districts data are supplied according to a condensed list of occupations and occupational groups. The statistics relating to industries will be published in a separate volume. The principle upon which the classification is based is the nature of the work performed, though in the case of the productive occupations the nature of the material worked in has been embodied in the scheme as a factor essentially determining the character of the operations. Full details of the classification, together with an alphabetical index of about 35,000 occupational terms, is published in a separate volume entitled *Classification of Occupations*, price 12s. net. On this occasion for the first time statistics of persons out of work at the date of the census are included. The classifications of such persons embrace all classes of the community, including those outside as well as those within the scope of existing statutory insurance schemes.

NON-SPECIFIC COLITIS IN RELATION TO DEFICIENCY DISORDERS AND ANAEMIA

BY

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Colitis is here used as a general term for a well-recognized clinical condition; "haemorrhagic colitis" and "ulcerative colitis" are considered as synonymous terms. Colitis is a sporadic disease occurring with some frequency in England and other temperate climates. The cause of this disease has always been very puzzling, for no specific infection has been found, though its chief symptom—diarrhoea with blood and mucus—suggests a relation to the dysenteric infections. Notwithstanding the failure to establish a definite intestinal infection, treatment has been to a great extent concentrated on the local condition, and colon lavage is employed almost universally, often assisted by irrigation from above through a stoma in appendix or caecum. The unreliable results of such treatment and its failure to prevent relapse are, however, generally acknowledged.

The purpose of this paper is to point out the resemblances of this disease to a deficiency disorder, and to urge treatment with high vitamin diets and, in particular, the vigorous treatment of the anaemia, when present, as a cure of this may be accompanied by an amelioration or remission of the colitis symptoms. Emphasis is laid on the necessity for massive doses of iron or liver. The temporary increase in diarrhoea or of other symptoms which often follows at the outset is no contraindication to continuing the treatment. Improvement in the bowel symptoms may be slow, especially at the beginning of an acute relapse, and perseverance is required. It is urged that all local treatment and sigmoidoscopic examination should be avoided if possible, as the bowel wall is highly susceptible to trauma; examples of the harm that may result are given. If colon lavage is continued, it may keep up the diarrhoea and bleeding, and cause apparent failure of other treatments.

Colitis a Deficiency Disorder

The evidence in favour of adding colitis to the list of deficiency disorders of the gastro-intestinal tract is gathered from experimental and clinical sources. The study of experimental vitamin deficiencies shows that both vitamin A and the vitamin B complex are necessary for the development of the healthy mucous membrane of the intestine and for maintaining its resistance to infection (Cramer,¹ Goldblatt and Benischek²). McCarrison,³ and Tilden and Miller,⁴ working with monkeys, found intense changes in the colon with vitamin-deficient diets, and in these animals the clinical signs of human colitis were closely reproduced. In human beings it is recognized that good nutrition may completely prevent the development of clinical dysentery, even though the amoeba is present in the gut. It is not suggested that non-specific colitis is the outcome of a gross diet deficiency in the majority of cases in this country; it may be due to a latent deficiency which is either inborn or acquired as the result of diet and disease. Colitis resembles a deficiency disease in that it occurs in attacks, with spontaneous remissions and relapses which follow without apparent cause; the first attacks are often slight and transitory, and each relapse tends to be more severe than the last. The highest incidence of the disease is in the second, third, and fourth decades.

A consideration of the functions of the colon is of interest. Starling states that its chief value in carnivora