THE ROLE OF ELECTRICITY IN TREATMENT *

BY

E. P. CUMBERBATCH, B.M.Oxon., D.M.R.E.Camb.,
M.R.C.P.MEDICAL OFFICER IN CHARGE OF THE ELECTRICAL DEPARTMENT,
ST. BARTHOLOMEW'S HOSPITAL

Various diseases can be cured or relieved, not only by electricity, but also by other physical agents or by pharmacological or surgical methods. When we speak of the role of electricity we should exclude the maladies which respond to simple forms of treatment.

INTRODUCTION

Electrotherapy is a specialty requiring for its proper performance an adequate training, much experience, and the possession of costly apparatus. For these reasons the fees which have to be charged are higher than those demanded for simpler methods of treatment. Thus, when we try to decide its role we should be thinking of the diseases in which electricity produces *quicker* or *better* results than other therapeutic agents, or those in which it succeeds after simpler measures have failed. It may be possible in the future to compile a list of these diseases. At the present time it is very difficult to give the names of even a few diseases in which there is general agreement that electricity is the best form of treatment.

I therefore feel that it would be better, on the present occasion, not to state the diseases for which we believe electrical treatment to be the best, but rather to discuss the ways in which electricity acts in rectifying pathological conditions. We may then be able to contrast them with the modes of action of other therapeutic agents, and say why we regard electrical treatment the best for this, that, or the other disease.

In suggesting a discussion along these lines I am not forgetting that the value of any form of treatment is assessed by the results that are obtained in clinical practice, and not by the findings of the physiological laboratory or by theoretical discussion. But the conditions which prevail at the present day in many of the hospitals render it difficult to procure a supply of clinical material, apart from the derelict stuff which usually finds its way to the electrical department. Even if the specialist had access to patients who had not yet been treated, except by the simplest methods, the task would be slow and arduous, requiring accurate diagnosis, a large number of patients, expert treatment, careful scrutiny of results, and a follow-up. Under present conditions there is yet another difficulty. Of the patients who are suffering from the same kind of complaint some may be referred to one department, some to another, and the same disease will be treated by different methods. The specialist in charge will make out a case for the method of treatment which is conducted in his own department. It is evident, then, that the task before us to-day is one of no ordinary difficulty.

In the preface to the sixth edition of his work on medical electricity, published in 1913, the late Dr. Lewis Jones wrote the following: "Whereas, in the past, there has been much uncertainty as to the modes of action of electricity in the body, we may now take our stand on firmer foundations, and may recognize that electrical applications act either by the chemical (ionic) effects which they produce, or by their thermal effects." This teaching lightened the darkness that had existed up to the beginning of this century, and enabled electrotherapy to commence its progress along rational lines.

* Read in opening a discussion in the Section of Physical Medicine at the Centenary Meeting of the British Medical Association, London, 1932.

THERMOTHERAPY

The chemical and physical changes that are induced in the tissues by electricity are followed by biological changes. Much is known of the nature of the chemical and physical changes—much remains to be discovered in regard to the biological changes, and the more we know of them, not only in diseased but also in healthy tissue, the more precisely shall we be able to assess the value and ascertain the role of electricity in therapeutics.

It is agreed by most workers that the therapeutic effects that follow treatment by high-frequency currents are due to that. High-frequency therapy, in fact, is thermotherapy. The heat is produced either in or on the body. The rise of temperature in consequence of the heat may not be high enough to damage the tissues. On the other hand, it may be sufficient to deprive them of life. There are various ways of utilizing high-frequency currents in the treatment of disease. They differ both in the distribution and in the degree of the heat, and I would suggest their inclusion under the title "the electro-thermic methods of medicine and surgery," restricting the name "high frequency" for the kind of current utilized.

The most widely employed of these methods is that in which the current is passed through the tissues for the purpose of raising their temperature *en masse*—that is, for producing diathermy. Since the heat, which is derived, "ready-made" as it were, from external sources, can raise the temperature of the deep-lying tissues, I think we may say that the role of electricity in thermotherapy is to heat the tissues which lie beyond the reach of heat derived from other sources.

Biological Effects

Certain important matters now arise for discussion. The first is the distribution of the heat generated by the diathermy current. It is commonly supposed that the current heats the tissues between the electrodes "through and through." But I do not think that there is more than the slightest rise of temperature in the vascular organs of the trunk when both electrodes are placed on the exterior. If anyone doubts this let him place a thermometer with its bulb in the posterior fornix vaginae, and pass a diathermy current through the pelvis by way of electrodes placed on the outside. Let him pass the current and increase its strength until the temperature of the skin reaches 114° F. For many minutes the thermometer will show no rise of temperature within the pelvis. There may be a rise of a fraction of a degree after a twenty-minute session. The resistance of the vascular organs of the pelvis is much lower than that of the skin and superficial fascia, and the current will heat these organs much less than the other parts. Further, most of the heat will be carried away by the blood stream.

When high temperatures are desired in the vascular organs of the trunk it is necessary to place one of the electrodes in close proximity to them. This is possible in the case of the pelvic organs, because there are channels that lead into the pelvic cavity, but it is impossible in the case of the abdominal or thoracic organs. How comes it, then, that we are able to relieve the severe pain that is felt in cases of angina pectoris by diathermy? Electrodes are placed over the praecordium and on the back of the chest, and there is reliable clinical evidence to show the value of diathermy in these cases. The problem is for the physiologist and pathologist to solve.

Nature of Changes

Having expressed the general belief, then, that the biological changes that follow the passage of high-frequency currents through the tissues are caused by heat, there remains the question of the nature of these changes.

Vaso-dilatation and acceleration of the blood flow occur. But what else? The pathologist may explain why heating, say, the infected cervix, for the very short period of ten minutes as infrequently as twice a week, can free the part of organisms—not only the gonococcus, but the *Streptococcus faecalis*, for which the lethal temperature is much higher.

What I have in my mind, however, is the influence of diathermy on the endocrine function of the ovary. The troubles that may arise at the time of the climacteric, such as arthritis, hyperpiesia, etc., when the ovarian functions are in a state of imbalance, can generally be put right by pelvic diathermy. There is strong evidence to show that the therapeutic results are due to the action of the diathermy on the ovaries. Dr. C. A. Robinson has been conducting pioneer work on diathermy in gynaecology for many years, and his experience is large and unique. I feel that his work has opened out a new era in gynaecology.

Just one more matter for comment. Can the biological effects of high-frequency currents be attributed to any change in the tissues other than the production of heat? For the purpose of teaching students I have adopted the pragmatic view, and I tell them that they must look upon diathermotherapy as a form of heat treatment. But do not regard me as destitute of imagination. Most of you are aware of the sad story of high-frequency treatment in France: how it was introduced by Professor D'Arsonval; how the *grand maître* observed the heating of the tissues but did not realize its importance; how the French electrotherapists used high-frequency generators that were incapable of producing much heat, and could not explain the mode of action of the currents; how high-frequency treatment was banished from France, only to return a few years later, its past life forgotten, and with a determination to start afresh under the name diathermotherapy. Quite recently there has appeared a book, *Les Ondes Hertiennes Courtes en Thérapeutique*, by Saidman and Cahen. The tissues can be heated when the body is placed in the field of the waves and diathermy is produced. The authors speak of a "quasi-specific" analgesic action of the waves. Is this a rumble of the distant thunder of the departing storm of controversy on the action of high-frequency currents? Or does it indicate the approach of a fresh storm?

SURGICAL USES OF HIGH FREQUENCY

The task of deciding the role of high-frequency currents in surgery is much less difficult than it is in medicine. Compared with medicine, surgery is more an art and less a science. The most recent of the surgical electrothermic methods is that in which the cutting arc takes the place of the scalpel. The sharp edge of the scalpel cuts the tissues in front of it. The arc, in addition, coagulates the divided surfaces. The depth to which the coagulation proceeds is largely under the control of the operator. It is obvious, then, that scalpel surgery is more exact. On the other hand, the arc seals the microscopic vessels when it severs them, and at the same time kills any bacteria or malignant cells in its path. These advantages are great when operations are conducted on infected or malignant tissue. Healing by primary union will likewise occur after the arc operation. A survey of recent surgical literature on the new surgery, and a perusal of the results achieved in cases of malignant growths, vascular tumours of the meninges, etc., shows the important role of the cutting current in surgery.

There are, in addition, other ways of utilizing electrically produced heat for surgical purposes. In one the heat is distributed through the part to be destroyed, and the temperature is raised until the tissue is coagulated

en masse. The actual cautery cannot bring about this diathermic coagulation: it produces too high a temperature in contact with the hot metal, and too low a temperature to coagulate the tissue a little distance away. By the electrical method and the production of diathermic coagulation the tissue is killed *en masse*, in addition, the microscopic vessels are sealed and infection is brought to an end.

There is the third electrothermic method of surgery—one which is of high value in cases which do not go to the surgeon. I refer to the method originally termed "fulguration"; a more descriptive term, however, is desiccation. In this method the abnormal or unnecessary tissue is killed by directing sparks upon it. The electrically produced heat deprives the tissue of its water: in other words, it dries or desiccates it. When tissue is killed in this way the inflammatory reaction is surprisingly small; it is almost negligible. Further, the scar that is left is better than that obtained by any other means. It is soft, smooth, supple, and does not contract. One which I have kept under observation over a period of twelve years is as good as it was when it first appeared. Electro-desiccation certainly has an important role in cosmetic work.

GALVANIC CURRENT

Let us now consider the galvanic current and its role in treatment. What can it do, and what can it do better than can other therapeutic agents? It can produce chemical caustics in the body, and these can be used for the destructive treatment of abnormal tissue. Treatment by electrically produced caustics is superior to treatment by ready-made caustics in the following respects. The former can be produced within the tissues, the quantity made is under the precise control of the operator, the reaction is slight, and the cosmetic results excellent. The method, of course, has its limitations—only a very small amount of tissue can be destroyed at each application. But whoever the specialist is, and whatever his speciality, be he enthusiast or nihilist, I believe there is at any rate one abnormal condition in which he will admit that electricity has a role. I refer to hypertrichosis. But there are other maladies in which electrochemical cauterization is a more elegant method than the use of ready-made caustics or the actual cautery—for example, stellate veins, telangiectases, simple papillomata of the skin, pedunculated warts, etc.

Ionization

There are various ways of introducing medicinal substances into the skin. The galvanic current is one of them. Since Professor Leduc introduced this form of treatment—ionization—at the beginning of the present century, there have been many hot discussions on the subject. It is now generally agreed that ions cannot be made to migrate more than a slight distance below the surface. But no method equals the galvanic when the operator desires to introduce ions into the skin, the accessible mucous membranes, the base of an ulcer, or the wall of a sinus. Within the range to which they can immigrate the ions may almost be said to saturate the tissue. Compare this with the almost imperceptible depth to which the ions pass by the process of diffusion, when lotions or irrigating fluids are brought into contact with the surface. We may say, then, that the galvanic current is indicated when one desires to introduce therapeutic ions into the superficial tissues to a depth beyond that which they can reach by diffusion. Compare the effects of irrigating the ear in a case of chronic suppurative otitis media with those following the immigration of zinc ions. Compare the results of packing the canal of the cervix uteri with antiseptics with those that follow the introduction of zinc ions.

The galvanic current possesses another therapeutic property, and I believe it to be of considerable value. I refer to its power to aid resolution of inflammation when progress by natural methods is stayed. This has been known since the middle of last century. I have in my possession a paper which was written by Leduc before he published his work on ionization. In this paper he describes the value of the galvanic current for the purpose I have just mentioned. It did not seem to attract much attention. But when the distinguished author made his investigations on ionization the attention of the profession was directed on the pharmacological properties of the ions rather than on the other actions of the current. Leduc's work on ionization came like a kindly light to lead us through the encircling gloom of galvanotherapy as it existed at the time. But we shall not be through the gloom until we know the action and method of action of galvanic current on the deep as well as on the superficial tissues. Fortunately, some clinical investigation on this matter has been made in recent times. During the past few years it has been the custom at the Miller Hospital to employ anodal galvanism in cases of Colles's fractures when there is undue pain and swelling. The treatment quickly relieves the pain, and the swelling subsides. Dr. C. B. Heald has had considerable experience on the use of anodal galvanism in cases of trauma.

THE SINUSOIDAL CURRENT

Before concluding I would like to say something—and ask something—about another current which has valuable therapeutic properties. I refer to the sinusoidal alternating current. It is potent in relieving pain in the later stages of neuritis. It is of high value in the treatment of the results of anterior poliomyelitis. It is not to be expected that the profession as a whole will consider these claims unless the method of action of the current is rationally explained. This explanation is still wanted. In the days when Lewis Jones was in charge of the electrical department of St. Bartholomew's Hospital, a very large number of cases of infantile paralysis were treated by sinusoidal current baths. Lewis Jones was the greatest English authority of his time on electrotherapy. In addition, he was a first-class neurologist. He had the highest opinion of the value of the sinusoidal current in the disease under consideration. Yet to-day we get scarcely a single case for treatment in the department. Perhaps a change will come when we know more of the method of action of the current. The study of the effects of stimulation of the skin and its afferent nerve endings, not only by the sinusoidal current, but also by other electrical methods, such as the brush discharge, and the influence of this stimulation on the arterioles and the ductless glands, may well lead to findings of importance in the treatment of disease.

CONCLUSION

Finally, in discussing the immediate effects of electricity on the tissues rather than the therapeutic results that are brought about, I would say that the role of electricity in the treatment of disease is the following:

1. To heat tissues which are beyond the reach of ready-made heat applied to the surface, with the object of procuring (a) the medical effects of heat, (b) the destructive effects, and, at the same time, the sealing of the microscopic vessels and the abolition of infection.
2. To cut tissue for surgical purposes, and at the same time seal the severed vessels.
3. To kill tissue by drying it, thereby causing a minimal reaction and producing the best possible scars.
4. To bring about the entry of therapeutic ions into the superficial tissues to a depth beyond the range of penetration by diffusion.

5. To kill tissue by producing chemical caustics within it.

6. Keeping in mind one of the physiological effects that electricity can bring about, we might add to the list: to procure vaso-dilatation and acceleration of the blood supply, and (probably in this way) to aid the resolution of inflammation.

THE TREATMENT OF PERNICIOUS ANAEMIA WITH FISH-LIVER EXTRACT

BY

L. S. P. DAVIDSON, B.A.CAMB., M.D., F.R.C.P.ED.

REGIUS PROFESSOR OF MEDICINE, UNIVERSITY OF ABERDEEN.

The investigations of Whipple and Robscheit-Robbins¹ into the relative value of different foodstuffs in the treatment of experimental haemorrhagic anaemia in dogs clearly showed that certain glandular organs—namely, the liver and kidney—possess remarkable powers of stimulating the regeneration of haemoglobin. These physiological studies may be said to have been the main factor which induced Minot and Murphy² to apply dietotherapy in the treatment of pernicious anaemia. The historical aspects of this subject have been adequately reviewed by many authors,³ and little more need be said except to draw attention to the statement of Whipple and Robscheit-Robbins that, although mammalian liver has extraordinary haemopoietic activity, fish liver is inactive. It has seemed to me that this might depend on insufficient dosage due to the nausea and lack of appetite engendered by the unpalatable nature of the material, or to gastro-intestinal disturbances secondary to the irritating effects of excessive amounts of fatty acids produced from the oil. Such factors might reduce the intake or lower the assimilation and absorption of the anti-anaemic material contained in fish liver. The rise in the cost of fresh mammalian liver from fourpence per pound in pre-war days to its present price of one shilling and the expense of liver extract, have made it extremely difficult for any but the well-to-do to face the financial strain which must be borne for the rest of his life by a patient with pernicious anaemia. The production of a cheap but potent liver extract is an economic problem of great importance, and one on which I have been concentrating for a long time. My appointment to the Chair of Medicine in a university town, the principal industry of which is the fish trade, gave me the desired opportunity of investigating the haemopoietic properties of fish liver.

After consultation with Professor J. J. R. Macleod, it was decided to approach Mr. Adrian Lumley, Director of the Scientific and Industrial Research Station, Torry, Aberdeen, and enlist his help. Mr. Lumley immediately appreciated the possible benefits which might accrue to the fishing industry if an active haemopoietic factor should be demonstrated in fish liver, and not only agreed to supply the material to us, but placed at our disposal the services of Dr. Lovern and Mr. Sharp to carry out any chemical investigations that might be required. I desire to record my thanks to the directors and the members of the staff of the Scientific and Industrial Research Station, Torry, Aberdeen, for their co-operation and help, which enabled this investigation to be brought to a satisfactory conclusion.

INVESTIGATION I

Before attempting to prepare an extract, it was decided to try the effects of feeding raw liver after removal of the main mass of oil. The livers were frozen solid, minced into small particles, and placed in large centrifuge tubes.