outer surface of the posterior wall of the spinal channel are sometimes exceedingly imposing. Continuous or interrupted bridges are to be seen between the vertebral bodies. The intervertebral discs seem to undergo a process of atrophy, the intervals between the adjacent surfaces of the bodies becoming narrower. In some cases there is to be seen complete synostosis of laminae, articulations, and bodies. Two or more vertebral bodies become firmly and inseparably united. One of my specimens coming from a juvenile subject clearly represents the result. The vertebrae have been united in three pairs, beginning from the lower lumbar and ending by the twelfth dorsal. The next three dorsal vertebrae (9-11) are also firmly glued together, showing traces of heavy destruction of the bodies. And yet there is no kyphotic curve of the spinal process line. The fact of the vertebral bodies having been impaired in this case emphasizes the common assumption that the anterior cancellous part of the column may not be exempt from the destruction. It seems to confirm the investigations of E. Fränkel, who was able to cultivate typhoid bacilli procured from bone marrow squeezed out of the spongy tissue of the vertebrae after death. The paradoxical absence of kyphosis in such cases is easily explained by the effect of previous ankylosing periostitis binding together the posterior halves of the laminae and locking the articulations. The same interpretation may be accepted for the rare occurrence of grave spinal cord symptoms in typhoid affections; paralysis from cord compression is not spoken of.

The picture of typhoid spondylitis as represented by the Roentgen plates is very characteristic. Attention is drawn to the narrowing or partial disappearance of the intervertebral spaces and to the lateral protrusion of the contiguous edges of the bodies. Dense vertical shades on one or both sides of the middle line reproduce the massive bridges of newly formed bone by which the posterior parts of the column are soldered together. A scoliotic curve may be occasionally seen as the result of asymmetrical disposition of the disease.

As regards the clinical symptoms of infectious spondylitis, it may be said that they differ very much from those in Pott's disease. Acute excruciating pain in the back is the chief complaint. Every least movement exaggerates the sufferings; the undulations of a spring mattress may bring them on. The exact situation of the process may be easily determined by manual examination, although kyphotic projection may be absent. Digital pressure reveals intense pain in the lateral parts of the spine. The soft coverings of the region involved may be thickened and oedematous. In some cases several foci of the disease are to be found in different levels of the spine. Fever of an intermittent type generally accompanies the process in its initial stage. Tendency to suppuration or the formation of fistulae is very rarely observed, the diagnosis thereby being deprived of bacteriological proof. According to our clinical experience and the bacteriological findings of Quinke, E. Fränkel, and others, one must allow the assumption that the involvement of the spine in the typhoid process is a frequent integrant part of the disease as a whole, the infection continuing to exist in a latent state. The awakening of the process is generally brought about by trauma, be it in the form of an early attempt to leave the bed or to resume physical work. Therein lies the explanation of the development of typhoid spondylitis some months or even years after recovery from the initial disease. The symptoms and clinical course of spondylitis produced by spotted or recurrent fever are similar to those above described.

The following case may be offered as an interesting addition to the general statistics of the subject:

L. M., aged 23, Red Army, infantry, admitted to the orthopaedic department May 21st, 1921. In November, 1919, he developed typhoid. In February, 1920, he began to suffer from pains in the back. Having re-entered service on August 12th after two months' leave he continued feeling the same pains. In December, 1920, he went through an attack of recurrent fever. Called up again soon after, he began to lose power in his legs in March, 1921. After a certain term of treatment in a military hospital he came under my care.

On admission his state was as follows: General health good. Robust complexion. Standing or walking absolutely impossible. Distinct signs of partial spinal cord compression in the form of ankle and patella clonus; Babinski's phenomenon; rigidity of muscles and weakness of the lower limbs; loss of muscular feeling in the toes; skin hyperaesthesia to pain on the level of the seventh to eighth dorsal segments, and hyperaesthesia to all kinds of sensation lower down. State of atactic paresis of the lower limbs. No trouble of the bladder or rectum. Examination of the spine shows a not clearly defined swelling between the shoulder blades corresponding to the fifth to seventh spinous processes. The integu-

ments of the same region oedematous and reddened. Fluctuation distinct. Palpation of the diseased area of the spine inflicts great pain, especially in the lateral parts of the vertebrae. Vidal's reaction of the blood positive. Temperature between 38° and 39° C.

Patient complains of great pain in the back, especially with every movement. On opening the abscess under general anaesthesia, on May 25th, slightly odorous grey-green pus was found, from which a pure culture of typhoid bacilli was obtained in the bacteriological laboratory of the Academy. There was no doubt about the identification of the micro-organism, as it showed all the usual tests. The cavity of the abscess was found to be located to the right of the spinous processes, leading deeply towards the corresponding laminae. No denuded bone could be felt during the scooping out of its contents.

The subsequent course of the case was favourable, although of long duration, spinal cord symptoms subsiding very slowly. The fistula, periodically closing and reopening, continued to produce pus containing the specific bacteria. Voluntary movements of the legs reappeared in July. The hyperaesthesia disappeared. Babinski's sign and clonus still persisted. By December, 1921, the patient was able to walk freely. At times he felt acute pains in the region of the operation. A probe periodically introduced into the fistula met with something hard resembling denuded bone. The attempts to extract the "sequestrum" were futile, although it seemed to be movable. On June 2nd chloroform was administered and the fistula cut open. With a strong forceps I extracted a foreign body, which proved to be the middle part of a penknife blade about 1½ cm. square, thus astonishing my staff and myself. The patient being eager, still in a drowsy condition, to see the obnoxious bone which had troubled him for so long, the piece of metal was shown to him. His look seemed to wander as if trying to recollect some distant event. "Yes," said he, after a pause, "there has been an affair." The details of the adventure were obtained on the next morning. In the winter of 1918, before he entered service, he took part in a sleigh trip in company of his equals containing representatives of his parish. Having the advantage of being able to play the harmonica, he was stabbed from behind by a jealous village comrade. The blade of the penknife broke into pieces on striking the vertebral laminae; its point probably penetrated the cortical layer of the bone and broke off. The small wound healed without any further trouble in a few days, and no subsequent attention was paid to the tragic event.

In need of a justification of my publishing the above case, I may point to the fact that it is the only positive one, according to my knowledge, in which typhoid spondylitis was complicated by suppuration. The bacteriological verification of the origin of the disease is also of singular interest. The previous trauma, which may have stimulated the onset of the suppuration, is also to be underlined. Symptoms of cord affection are a not very frequent concomitant in typhoid spondylitis.

The wound having healed in two weeks, the patient walked out of the clinic on June 29th, 1922, with some traces of nervous disorder in his legs.

TREATMENT BY DIATHERMY.*

BY

W. J. TURRELL, M.A., M.D. OXON.,

ELECTROTHERAPEUTIC PHYSICIAN, RADCLIFFE INFIRMARY, OXFORD.

THE title of this communication does not necessarily imply the adoption of any electrical method. It simply refers to treatment by penetrating heat. The subject consequently admits of division into two parts: (1) the therapeutic effects of heat penetration; (2) the most effective method of securing this penetration, having due regard to its safety, the ease of its regulation, and its capability of application to the body as a whole or any organ or part of the body.

As to the first part there can, I think, be no difference of opinion in regard to the great importance of heat as a therapeutic agent. Its value has, in fact, been admitted from the earliest times to which medical history extends, and probably no method of therapy has been more unquestionably or more universally adopted.

A variety of methods have been utilized for applying heat treatment—hot sand, hot bricks, poultices, radiant-heat baths, sun baths, paraffin baths, and many others too numerous to mention; but the therapeutic value of all these methods is distinctly and definitely limited, for the simple reason that their action is restricted to the surface of the body and the superficial tissues, and cannot be brought to bear directly upon the deeper organs and structures. They are consequently useless as agents for treatment by diathermy or heat penetration.

There is only one known method by which heat can be

* A paper read at the annual meeting of the Oxford and Reading Branch of the British Medical Association, July 15th, 1922.

directly applied throughout the body as a whole or concentrated on any limb, on any organ or part of the body, and this is by the electrical method commonly known as diathermy, the outcome of the research of the distinguished French physicist d'Arsonval.

Mode of Action.

This fact well illustrates a very important point in relation to electrical treatment. In the past electrotherapy has been regarded by many patients, and, indeed, by some medical men, as an empirical and mysterious form of treatment passing all human understanding. In reality it is nothing of the kind; its value, on the contrary, rests upon the fact that it is often the best means by which some well established method of treatment can be carried out; as in the present instance, it is the most effective method of administering heat; in other cases it is the best method of producing muscular exercise, localized or general; or again, it may be the best means of effecting chemical or other changes in the tissues. I will endeavour, as simply and as briefly as I can, to explain in what manner this heat penetration is electrically obtained.

An electrical current may be in the form of what is termed a constant current—that is to say, a current which is maintained at a uniform strength, flowing in the same direction without interruption, reversal, or variation; such is the direct current, the D.C. of commerce. Or, on the other hand, it may be interrupted and its direction reversed at each interruption, as in the alternating current, the A.C. of commerce, with its usual periodicity of about fifty reversals a second.

Provided that the constant current is applied to the body very gradually no muscular contraction will be excited, but during the whole of its passage an acid such as HCl will be formed on the skin at the positive pole by what is termed electrolytic action, and an alkali such as caustic soda will be similarly formed at the negative pole. With the small constant currents usually applied in electrotherapy these phenomena will produce no bad results; but if a very strong current is applied these products will cause serious burns of the skin or subcutaneous tissues; the amount of current which can be safely applied is therefore insufficient to produce any very marked heating effects.

On the other hand, in the case of the alternating current, changing its polarity from positive to negative fifty times a second, the danger of such burning is absent as the alternating products neutralize one another. But at each sudden make or reversal of the current strong and painful muscular contractions are excited, and if a very strong current was employed the effects might even result in the death of the patient.

In 1888 d'Arsonval found that by increasing the number of the interruptions a second of a current at a given strength, the resulting contractions became more vigorous as the interruptions became more frequent; until a rate of interruption of from 2,500 to 5,000 a second was reached, when a further increase in the frequency resulted in a diminished vigour of the contractions. In December, 1898, using the apparatus of Hertz, d'Arsonval attained a frequency of interruption or oscillation of about a million a second, with the result that all contractions and sensation were abolished, and only the heat generated by the friction resulting from the oscillation of the electrical particles (the ions conveying the current) remained. This constituted the discovery of high-frequency currents, and by subsequent improvements in the apparatus the frequency of the oscillations was further increased, yielding the diathermic currents of d'Arsonval.

I will merely state that in its main principles the apparatus is identical with the transmitting apparatus of wireless telegraphy, and it admits of the passage through the body with perfect safety of currents of 2 or 3 amperes—that is to say, a hundred times or more stronger than could be transmitted by the continuous or alternating currents. The only effect of the transmission of such currents through the body, apart from a probable stimulation of the tissue cells due to the perturbation excited by these oscillations, is the generation of heat of any desired amount within any organ of the body. According to the density of the diathermy current employed, this method of heat penetration may be utilized for either medical or surgical purposes.

When a diathermy current of moderate intensity is applied transversely through large areas of the body, or longitudinally through the limbs, the temperature of the body at first rises to about one degree above normal, and the pulse becomes accelerated about 10 beats a minute; then, as the heat-regulating centres come into play, the pulse becomes softer and fuller, the temperature returns to normal and will remain normal for the rest of the treatment, although it may be continued for an hour or more at the same intensity. By passing very large currents such as 17 amperes and over through the body a marked rise of the general temperature can be obtained, and if such currents are continuously administered for a considerable time, as has been done in experiments on animals, the action of the heat-regulating centres will be overcome, and the animals will die of hyperpyrexia.

A very small current, such as 300 ma., does not appear to call the heat-regulating centres into action to a relatively marked

extent, and consequently with small currents a relatively greater heating effect may be obtained. Thus it has been shown that on heating the stomach by a diathermy current of 300 ma. the temperature of that organ was raised to half a degree above normal, but, on increasing the current to ten times that strength, the temperature of that organ fell to only one-third of a degree above normal.

Medical Applications.

The importance of these experiments is that they show the immediate and consecutive effects of diathermy. The first effect is to raise the temperature of the part treated; the later effects are a relaxation of the tissues, a dilatation of the blood vessels, and consequently an increased blood supply to the part treated. In this way the therapeutic effects of diathermy are explained—namely, the lowering of the blood pressure, the relaxation of spasm with the relief of pain, and an improved nutrition of parts whose blood supply has been deficient.

Without attempting to formulate any new theory of pain, I should like to recall the intimate and causal relationship which exists between pressure and pain; it is by relieving spasm and pressure, and hence removing pain, that diathermy finds one of its most important indications in clinical practice. Neuritis, deep-seated pain such as that associated with dysmenorrhoea or the spasm of a ureter excited by the passage of a calculus, the hypertonicity of the lumbar muscles in lumbago or the neck muscles in torticollis, the muscular rigidity of local tetanus, the pain and tenderness of a recently strained ankle, and many other conditions too numerous to enumerate, are usually markedly relieved and often permanently cured by the application of this treatment.

The nutritional effect of the increased blood supply induced by diathermy is constantly seen in the improvement which takes place in wasted limbs and atrophic conditions treated by this method.

Hypothermic and marasmic conditions are much relieved and improved by generalized diathermy. Bergonié has advanced the ingenious theory that its administration in these cases affords what he terms a "supplementary ration of heat"—that is to say, he maintains that, as the greater part of the food taken is diverted to the maintenance of the body temperature, if heat is furnished to the body by diathermy the food previously diverted for this purpose would be utilized for the nourishment and building up of the tissues. Bergonié further points out that the custom of giving additional food, owing to the weakened digestive mechanism associated with these marasmic cases, merely serves to add the troubles of indigestion to those already existing. Bergonié has published several cases in proof of his contention; moreover, the theory would appear to receive some support from the improved nutrition of rickety children exposed to the prolonged action of the sun bath; for such improvement may be partly due to the gradual action of the heat rays from the sun and partly due to the action of its actinic rays.

When we realize the very wide application of heat therapy it is not surprising to find that diathermy is continually extending its sphere of action. To mention only a few of the recently adopted indications, Professor Bordier, in the excellent and exhaustive volume on diathermy which he has recently published, draws attention to the great benefits attending the adoption of this treatment in certain cases of dyspepsia, and quotes a number of cases investigated by Setzu to show how it increases both the total gastric output of acids and of free hydrochloric acid. Setzu's carefully investigated cases definitely show how the secretion of a deeply seated organ may be increased by the administration of penetrating heat, and suggest a wide field for research on the effect of diathermy on ductless glands whose secretion has become deficient.

The special vulnerability of gonococci to high temperatures renders possible their destruction, or an impairment of their vitality, at temperatures obtainable from diathermy and readily supportable by the tissues, and thus renders this treatment a specific in gonorrhoea and most of its complications. Many other conditions, such as asthma and unresolved pneumonic consolidation, will suggest themselves as especially suitable for gradual and prolonged diathermic treatment at low intensities, but time forbids me to deal further with the medical aspects of diathermy and I must pass on to its surgical side.

Surgical Applications.

In surgical diathermy the heat, which in the medical applications is distributed over a comparatively large area, is concentrated on one spot. It differs from the destruction of tissue by heated irons or the Paquelin cautery in that

when properly applied it effects the destruction by heat coagulation and not by charring or incineration.

Those who have used the Paquelin cautery will remember how the charred tissues adhere to the blade of the instrument and become separated from the heated surface of the part treated, so laying open a bleeding surface. In surgical diathermy the instrument utilized is not itself heated, the whole of the heat being developed in the part treated; it consequently does not adhere to the tissues but comes cleanly away, leaving them undisturbed but firmly coagulated to a sufficient depth to prevent haemorrhage.

It is not claimed that surgical diathermy is an absolutely fool-proof method, for if it is applied incautiously in the neighbourhood of large vessels the wall of an imperfectly coagulated vessel may be laid open and fatal haemorrhage ensue. Such an occurrence has been recorded by Bordier and others in the destruction of malignant tonsils by diathermy. The risk of haemorrhage from surgical diathermy, if it is applied in a rational manner and with due regard to the anatomical relations of the part treated, is exceedingly small.

The methods of its application are threefold: the unipolar method, utilizing a small active and a large indifferent electrode; the bipolar method, using two small active electrodes; the indirect method, in which the patient, lying on a condenser couch attached to one terminal of the apparatus, and holding an electrode connected with the other terminal, is charged with a suitable diathermic current, which is tapped off to the body of the operator at the point to be destroyed.

For the destruction of most superficial growths, sufficiently removed from important underlying structures, such as large blood vessels, nerves, glandular ducts, etc., the unipolar method is usually the most convenient one. It is, however, difficult with this method definitely and accurately to restrict the depth to which the coagulating action of the heat will extend, and in the neighbourhood of important structures it is best to delimit the destructive action of the current by the adoption of the bipolar method. In this case two small active electrodes of the same size are applied to the surface of the part to be treated, and the destructive action is limited to a slight and readily recognized depth. The destructive action may, however, be still more effectively controlled by the use of electrodes provided with multiple points of the required length. These electrodes consist of small plates, from the under surface of which several needles project; by plunging each of the instruments, at a suitable distance from one another, into the growth to be destroyed, the action of the current reaches with certainty to the desired depth, and cannot extend more deeply.

The indirect method, which I introduced some years ago, is especially suitable for the treatment of small growths, naevi, papillomata, warts, urethral caruncles, epulides, etc. The advantages are that it is the most accurate method and the least painful; the instrument held by the operator is unencumbered with any wires, and as the amount of the current employed is registered by the amperemeter of the apparatus before the treatment is started, the amount of current can be suitably adjusted

before the operation is commenced. If with the patient charged in the manner described a papilloma or other growth with a narrow pedicle be held by the operator by means of metal forceps, the narrow base of the pedicle will coagulate and the growth will painlessly separate.

Intravesical growths, haemorrhoids, superficial growths, malignant or otherwise, on the surface or within accessible cavities, lupus, moles, enlarged tonsils, naevi, and many other conditions are suitable for surgical diathermy; it is also a most delicate and efficient means of epilation. Speaking from my own experience, my greatest success with surgical diathermy has been in the treatment of haemorrhoids. Intravesical growths are best treated by a surgeon specializing in diseases of the bladder, as the cystoscope is a far more difficult instrument to use than the diathermy instruments; in fact, I am of opinion that all the more severe diathermy operations, such as the destruction of large malignant growths, belong rather to the surgeon than to the electro-therapeutist.

Concluding Remarks.

I have endeavoured to give a brief summary of the therapeutic action of diathermy. It is, of course, impossible to deal adequately with so large and important a subject in so brief a time; indeed, we have by no means as yet fully developed the therapeutic possibilities of heat penetration by electrical means. As Bergonié points out in his introduction to Bordier's book on diathermy, the end of the last and the beginning of the present century have given us the high-frequency currents of d'Arsonval, the x rays of Röntgen, the radium emanation of Becquerel and the Curies; but the period which has as yet elapsed since their introduction has proved insufficient to enable us to develop fully their methods of application or even to visualize fully their wide-reaching and revolutionary effects.

Every new discovery in Medicine, whether electrical, pharmaceutical, or surgical, is invariably heralded as an epoch-making discovery, and from its application miraculous results are confidently predicted, which the lapse of time fails to realize. We have in the past, as Bergonié says, seen every illusion flourish and have heard every physical panacea preached. It is only by patiently and critically investigating the clinical action of these new methods and by carefully tracing out their fundamental basis that we are able to establish them upon a sure and lasting foundation. Working upon such lines as these, the modern school of electro-therapeutists, both in this country and abroad, may fairly claim to have placed the high-frequency currents of d'Arsonval upon the firm and far-extending foundation of heat penetration, and upon this basis to have secured for them an important and enduring position among the therapeutic methods of the future.

The FitzPatrick Lectures

ON

THE POST-HIPPOCRATIC SCHOOLS OF MEDICINE.

DELIVERED BEFORE THE ROYAL COLLEGE OF PHYSICIANS OF LONDON,

BY

R. O. MOON, M.D., F.R.C.P.

[Abstract.]

In my lectures in 1921 I endeavoured to show how Hippocrates had been influenced by the great Ionian philosophers who had preceded or been contemporary with him, and by the scientific and general intellectual atmosphere in which his writings had been composed.

Just as after the death of Socrates the essential unity of his teaching broke into a variety of schools—such as the Cynics, Cyrenaics, Megarians, and, in particular, the followers of Plato—so after the death of Hippocrates, medicine became split up into a number of sects, each at its best emphasizing some important aspect of medical truth, but each in turn, as is the habit of all sectarianism, running into strange extremes, and remaining incapable of grasping the Hippocratic system as a whole.

The post-Hippocratic schools of medicine, which were four in number—(1) the Dogmatists, (2) the Empirics, (3) the Methodists, (4) the Pneumatists—occupy perhaps a somewhat unimportant sphere in the history of medicine, but the great

philosophic schools of the Stoics, Epicureans, Sceptics, and Eclectics which influenced them, and of which, in a sense, they were the practical outcome, are famous through all time, and some attempt will be made to describe them when trying to explain their points of contact with medicine.

THE DOGMATISTS.

The school of the Dogmatists in its prime synchronized with the decline of Hellenic freedom and with the rise of the Macedonian hegemony. This school received its name from Galen, and, though not very happily chosen, it must be retained for convenience. If we were to call them "theorists" we should come nearer to the essential idea which they represented in the ancient world. To the modern mind dogmatism is suggestive of a certain degree of intellectual rigidity and aridity which were certainly not characteristics of this ancient medical school. But they suffered from what Bacon called that first distemper of learning, when men study words and not matter.

The most important member of this school, though not the actual founder of it, was Diocles of Carystus, who flourished soon after the death of Hippocrates. He was born at Carystus in Euboea (400 B.C.). The greater part of his life was passed at Athens, and with pride he was termed by his fellow citizens "a second Hippocrates." He was the first physician to write in Attic Greek, and his writings covered the whole field of medicine—namely, Physiology, Anatomy, Dietetics, Pharmacy, Pathology, Therapeutics, and Prognosis. He was first to isolate pleurisy from pneumonia, declaring that the seat of pneumonia was in the vessels of the lungs.

Speaking generally, in his dietetic writings Diocles adopted