A Paper

ON

DISORDERS OF THE SYMPATHETIC NERVOUS SYSTEM AND THEIR RESPONSE TO MEDICAL AND SURGICAL TREATMENT *

BY

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A hundred years ago the first glimmerings which heralded the dawn of modern neurology are recognizable. Periods of activity, which from time to time characterize all the sciences, are determined by discoveries which constitute the milestones of progress; and the study of history, quite apart from its inherent interest, is often helpful in enabling us the better to appreciate current problems. A brief reference to the progress of neurology during the past century is instructive by way of introduction and is justified by the occasion.

THE BIRTH AND PROGRESS OF NEUROLOGY

Sir Charles Bell¹ reported his observations upon the functions of the spinal nerve roots and peripheral nerves—observations which have been compared in importance with those of Harvey upon the circulation of the blood—little more than a hundred years ago (1811). Waller,² in 1852, published his classical work on secondary degeneration; and Broca³ nine years later (1861) initiated the doctrine of localization of function in the cortex of the brain when he showed that articulate speech is abolished by disease which destroys that particular region with which we now associate his name. These three discoveries were, I submit, chiefly responsible for the remarkable progress in our knowledge of the nervous system during the latter half of the nineteenth century. They may be said, indeed, to constitute the birth of neurology as a science.

Thus it was that the attention of the clinicians was directed to the problems of localization, the correlation of symptomatology with morbid anatomy, the differentiation of diseases and clinical entities, and the significance of physical signs. New possibilities too were opened up to the physiologists, who applied themselves to the investigation of function by experimental methods, simplified by the introduction of chloroform in 1847 and antiseptics in 1867. They were thus able to corroborate and extend the conclusions arrived at by the clinicians. With the introduction of the selective staining methods devised by Golgi, Marchi, Weigert, and Nissl, the neurone conception was gradually evolved, and the anatomists and pathologists added greatly to the existing state of knowledge as to the anatomy of the brain, spinal cord, and peripheral nerves, the course of nerve tracts, the histology of the nerve cell, and the architectural structure of the cerebral cortex. But as the nineteenth century drew towards its close there were indications that morbid anatomy had had its day and that a new era was dawning in which physiological conceptions were replacing the more strictly anatomical outlook. The names of the two great English masters—Hughlings Jackson, the observer and philosopher, and Sir Charles Sherrington, the physiologist and investigator—will ever be remembered in this connexion. Again, an impetus was given to the psychological aspect of disease by the studies of Dubois, Déjerine, Janet, and

others; and the hypotheses of Freud and his successors opened up unexplored regions and methods of approach which gave new life to clinical psychology. Let us leave this reference to neurological progress as we find it at the end of the nineteenth century and turn to the autonomic nervous system, which at that time began to engage attention.

KNOWLEDGE OF THE AUTONOMIC SYSTEM IN ITS INFANCY

The choice of subject for this Centenary Meeting would appear to be singularly appropriate, for it requires no prophetic acumen to predict that we are on the threshold of a period in which the activities and disturbances of the autonomic system will occupy a progressively more prominent place in the considerations of the clinician. It is indeed more than probable that increasing knowledge of its reactions and disorders will profoundly modify our existing conceptions of disease. A vast literature has been accumulating which demands sifting and correlating from the point of view of those of us who are of necessity primarily interested in the possibilities of its practical application.

Prior to the last few years but little attention was paid by the clinician to the autonomic nervous system. Nor is this surprising when the lack of anatomical and physiological knowledge necessary for scientific sympathetic interpretation is recalled. The gross anatomy gives the impression of extraordinary complexity; inferences derived from obvious pathological and experimental lesions are consequently difficult; while the method of Wallerian degeneration which proved so fruitful in the investigation of the central nervous system and peripheral nerves has here but a limited application. How refreshing it is to read the words of the physiologist, Marshall Hall,⁴ who wrote of the "ganglionic nervous system" ninety years ago, at a time when speculation ran rife:

"Everything . . . is only to be observed by its effects. It is therefore by inducing and observing the pathological effects of a subtraction of the influence of this system that we are led to discoveries in regard to its physiology; and it is therefore under the head of pathology that the subject must be treated of."

Half a century ago nothing was known about the physiological anatomy of the autonomic system, and its purpose as a functioning mechanism was still a closed book. New lines of approach had to be devised to afford information regarding what appeared to be a complicated tangle. Yet, despite the progress that has been made of recent years, it must be admitted that our pathological and clinical knowledge is still in its infancy.

The opener of a discussion upon the autonomic system is indeed confronted with a task of unusual difficulty. A general sketch is, however, called for with which to preface the remarks of subsequent speakers who will deal with individual aspects of the subject. This it will be my purpose to attempt.

THE PIONEER WORK OF THE CAMBRIDGE PHYSIOLOGISTS

The investigations of Gaskell, which were published in 1887-9, and of Langley and his collaborator H. K. Anderson, during the years that followed, have been referred to as one of the brightest stars in the crown of British physiology. It was they who unravelled the scheme of the efferent autonomic system. A reference to their work is apposite, not only because of its paramount importance and historic interest, but since the procedures employed in the great advances for which they were responsible are thereby illustrated.

Gaskell approached the problem from a novel point of view. The presence of small medullated nerve fibres in

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the anterior thoracic nerve roots had long been noted. As the result of laborious research he proved that these fibres arise in the intermedio-lateral cell column of the lateral horn of the thoracic and upper lumbar region of the spinal cord, that they leave the anterior nerve roots by way of the white rami communicantes, that they are destined for the supply of the viscera, and that some of the cranial and sacral nerves contain fibres of the same type with a similar distribution. He demonstrated, in fact, that the viscera receive fibres not only from the thoracic region of the spinal cord, but from the brain stem and sacral region, and he argued that the action of these two sets of fibres is antagonistic, the former probably having a katabolic, the latter an anabolic, function.

Langley did much by his numerous degeneration experiments and histological observations, and particularly by his work with nicotine, to further the progress of knowledge. Thus *inter alia* he proved that the small medullated fibres in the anterior thoracic nerve roots (the pre-ganglionic neurones) enter the sympathetic ganglionated chain of the same side, in which they pass either in a cephalic or caudal direction to form connexions with the nerve cells of the chain (the vertebral ganglia) at different levels. Again, he demonstrated that from these nerve cells another series of nerve fibres arise (the post-ganglionic neurones) which are usually non-myelinated, and that they pass to peripherally situated ganglia (the pre-vertebral ganglia) from which fresh relays of fibres spring, to be distributed to the various viscera. Langley established the general anatomical plan of the efferent autonomic system as we now know it; he demonstrated that adrenaline has a selective stimulating effect upon the sympathetic system; and in conjunction with his colleague Anderson he did much to elaborate the details of autonomic innervation. Then, too, it was Langley and Anderson who first described the axon reflexes; and it was they who definitely proved that the dilatation of the pupil which results from stimulation of the sympathetic is due to the contraction of radially arranged muscle fibres.

NOMENCLATURE

The variety of names which have been applied to the system under consideration must be confusing to the practitioner. Reference is found in the works of the earlier writers to "the organic" and "the ganglionic" nervous system, expressions which are now obsolete. Gaskell spoke of "the visceral system"; but since these fibres are not restricted to the supply of the viscera this terminology has been abandoned. A similar objection may be taken to the term "vegetative system," which is still sometimes used, especially by American writers. Occasional references to "the involuntary system" are met with in the literature.

A uniform terminology is much to be desired. The nomenclature here employed, which is in very general use, is that of Langley, who suggested the term "autonomic" with which to denote the system as a whole, and the terms "sympathetic" and "parasympathetic" for its thoracic and cranio-sacral subdivisions respectively.

THE CLINICIANS BECOME INTERESTED

But while the physiologists and pharmacologists were stimulated by Gaskell and Langley's investigations, the practical application of their work was not generally recognized by the clinicians—despite the valuable observations of L. R. Müller and others—until many years later. It was, I think, the publications of Eppinger and Hess⁵ (1909) upon vagotonia and sympathicotonia, and of Crile (1915)⁶ and Cannon (1915)⁷ upon the emotions—the former based largely upon clinical observation, the latter largely upon experimental evidence—which were chiefly

responsible for arousing the interest of the clinicians and directing their attention to the autonomic disorders. Langdon Brown's Croonian Lectures,⁸ published four years later (1919), did much to familiarize the profession in this country with the work that had been done. Then, in 1924-5, the results of Hunter's suggestive investigations⁹ upon the dual innervation of muscle and the question of muscle tone appeared, and these, with Royle's operative experiences, concentrated the attention of the surgeons.

ANATOMICAL CONSIDERATIONS

Reference to certain well-established anatomical facts is desirable, though it is with diffidence that I tread ground which to most of you is so familiar.

Dissection reveals: (a) the two *sympathetic chains* which lie one on either side of the ventral aspect of the vertebral column and extend from the atlas to the coccyx (the bead-like swelling on the chain—the vertebral or lateral ganglia—correspond in number to the spinal nerves, except in the cervical region, where there are only three); (b) the *white rami communicantes* are met with in the thoracic region—they pass from the anterior nerve roots to the vertebral ganglia—and the *grey rami communicantes* which pass from all the vertebral ganglia to the corresponding spinal nerves; and (c) *complicated plexuses of nerve fibres*, especially in the neighbourhood of the viscera and outlying ganglia (the prevertebral or collateral ganglia), of which the coeliac, superior and inferior mesenteric, and pelvic are notable examples.

As the result of information derived from various methods of investigation we know that the *efferent peripheral sympathetic* fibres are divisible into three groups according to their distribution—thus: (a) The viscera are innervated by fibres (the pre-ganglionic neurones) which arise in the intermedio-lateral cell column of the thoracic region and pass by way of the white rami communicantes to the sympathetic chain of the same side in which they terminate at various levels. A second relay of fibres (the post-ganglionic neurones) spring from the cells of the vertebral ganglia of the sympathetic chain and pass to the outlying prevertebral ganglia, from the cells of which other fibres arise and proceed to their terminations. Small groups of cells, such as the plexuses of Auerbach and Meissner, are met with in the wall of the alimentary tract and are sometimes referred to as terminal ganglia. (b) The cutaneous blood vessels and sweat glands, with the exception of those of the head and neck, are innervated by post-ganglionic fibres which arise from *all* the vertebral ganglia and pass by way of the grey rami communicantes to the corresponding spinal nerves, by which they are distributed, without the intervention of intermediary ganglia, to the associated segmental areas on the surface of the body. (c) The fibres destined for the supply of the dilator of the pupil, the unstriped muscle of the upper eyelid, the submaxillary gland, and the cutaneous blood vessels and sweat glands of the head and neck, leave the spinal cord by the first and the second thoracic anterior nerve roots; they enter the sympathetic chain (often referred to in this region as the "cervical sympathetic") in the lower cervical region and pass in the chain to the superior cervical ganglion, from which they proceed to their ultimate destination. Little is known as to the course of the *efferent sympathetic fibres*, and a reference to interesting recent work in this connexion is beyond the scope of this brief sketch. The *efferent peripheral parasympathetic* fibres have, you will recall, three sources of origin—thus: (a) The sphincter pupillae and muscle of accommodation are innervated by fibres which arise from cells in the mesencephalon and are carried by way of the ciliary ganglion to their destination. (b) The thoracic and abdominal viscera are largely supplied by fibres distributed by the vagus nerve. (c) The musculature of the genital organs, bladder, and rectum receives a nerve supply from the sacral region. The further question as to the presence of higher governing autonomic centres in the hypothalamic region of the brain has been the subject of much interesting recent work. It has long been recognized that the cervical sympathetic must have a governing centre in the brain, since pathological lesions in the medulla and cervical region of the

spinal cord may produce the same paralytic phenomena (myosis, ptosis, etc.) which result from interruption of the cervical sympathetic. Further, data derived from various methods of investigation (comparative anatomy, clinical and experimental) point to the existence of a sympathetic governing centre in the hypothalamic grey matter in the floor of the third ventricle, and corroborative evidence has recently been afforded by the demonstration of a tract of nerve fibre which passes from this region to the lateral horn of the spinal cord.¹⁰ There would also appear to be a higher parasympathetic centre in the same neighbourhood. Cushing¹¹ has brought forward evidence in this connexion, and Beattie¹² has shown experimentally that stimulation of this "centre" produces both gastric peristalsis and secretion. The latter has found—an observation of interest to the clinician—that after prolonged stimulation of this region small areas of hyperaemia may be demonstrated in the gastric mucosa near the lesser curvature. The speakers who follow me will no doubt have something to say regarding recent work on the autonomic centres in the diencephalon and the interesting question of the relation of the hypothalamus to the pituitary.

GENERAL PHYSIOLOGICAL CONSIDERATIONS

The autonomic, in contrast to the voluntary system (which is exclusively concerned with the innervation of the striped or voluntary muscles), supplies the unstriped muscles of the body, the various viscera and glands, the organs of generation, the bladder, the blood vessels, glands, and erectors of the hair, and the muscle of the iris. It is now acknowledged that the arteries of the brain receive a controlling autonomic nerve supply, and of recent years weighty evidence has been advanced which suggests that the skeletal muscles may be directly innervated by sympathetic fibres.

Evidence available from various lines of investigation indicates that the autonomic nervous system, unlike its cerebro-spinal counterpart (which dominates voluntary movement), is exclusively concerned with the involuntary processes associated with the internal economy of the organism. It has to do with nutrition, excretion, and metabolism generally, with propagation, and with the internal mechanism demanded in relation to effort and defence. The sympathetic and parasympathetic systems are antagonistic in their mode of action, the function of the former being essentially katabolic and that of the latter anabolic and restorative. While the parasympathetic is concerned with the normal functioning of the organs it supplies, it exerts at the same time an inhibitory influence over the sympathetic—the chief function of the latter being that of a defence mechanism which is brought into play in states of emergency when any special effort is called for. According to W. B. Cannon¹³ the chief function of the sympathetic is to preserve the balance and operate when there is a disturbance in the fluid matrix or internal environment of the organism. Thus during exercise the sympathetic system releases sugar from the reserves, disposes of the extra heat so produced by its action on the vessels of the skin and sweat glands, and by promoting the rapidity of the blood flow and liberating extra corpuscles from the spleen it enables the blood to carry more oxygen from the lungs to the active tissues and more carbon dioxide in the opposite direction. The parasympathetic, on the other hand, builds up the reserves, for it slows the action of the heart and increases the blood supply to the alimentary tract. Thus, while the voluntary or somatic efferent system is concerned with the external environment of the organism, the autonomic system, as Cannon remarks, "collaborates with it in rendering the organism as a whole continuously efficient."

But while the sympathetic system is constituted for widespread effects it may also play a local protective part. The rigidity of the adjacent muscles and the referred pains and areas of cutaneous hyperaesthesia, with which

we are so familiar in cases of acute visceral disease, must obviously be determined by reflex activities designed for protective purposes in which the sympathetic is intimately concerned.

The activities of the autonomic system in relation to the endocrine glands raise many interesting problems, to which it is impossible to refer. The thyroid which controls metabolism, the anterior lobe of the pituitary which is concerned with growth, and the suprarenals which are called upon in times of emotional disturbance and when exceptional effort is demanded, would appear to be under the influence of the sympathetic. On the other hand, the parasympathetic would seem to be closely related to the pancreas, the function of which is to store substances which afford the necessary energy for tissue use.

Some most interesting work has recently been carried out by Cannon and his collaborators,¹³ who have shown that the entire sympathetic chain from the superior cervical ganglion to the pelvic ganglia may be removed on both sides in cats, dogs, and monkeys, and that the animals survive for indefinite periods in the laboratory and show no abnormality where they are not exposed to cold or undue fatigue. They have also demonstrated that after unilateral removal of the sympathetic in young kittens there is no demonstrable difference in the growth of the kidneys, adrenals, thyroid, or long bones on that side, and that female cats and dogs may give birth to young after complete removal of the sympathetic. Again, it is of interest to note that, as both Sharpey-Schafer and McSwiney have shown,¹⁴ animals may survive in an apparently normal way after section of both vagi.

THE SYMPATHETIC SYSTEM, THE SKELETAL MUSCLES, AND MUSCLE TONE

Histological proof that the skeletal muscles are innervated directly by sympathetic fibres, apart from the nerve supply to their blood vessels, is not perhaps conclusive, and the experimental investigations upon which Hunter based his conclusion that the sympathetic nerve supply to skeletal muscles has to do with muscle tone have been severely criticized. I am tempted in passing to mention a clinical point which is, I think, of some interest in this connexion. Is it not a striking fact that there is a dual mechanism, in which both the third nerve and sympathetic take part, which has to do with elevation of the upper eyelid? I speak subject to correction when I say that I know of no parallel instance in the body in which two muscles—one supplied by a cranial nerve and the other by the sympathetic—act in the same direction. Further, is it not the case that the ptosis which occurs as an immediate consequence of division of the cervical sympathetic must be due to loss of tone in the muscle which these nerve fibres supply? May it be then that in the upper lid a special arrangement exists, for some reason which is not obvious, whereby the muscle fibres supplied by the sympathetic and voluntary systems, which in the skeletal muscles are indistinguishable, are here separate and distinct? Objection may be taken to this suggestion on the grounds that there is no convincing proof of the existence of separate unstriped muscle fibres in the upper lid. But if this is so my argument is thereby strengthened, for it must then be admitted that the ptosis which follows sympathetic denervation can only be explained on the assumption that the levator palpebrae, a skeletal muscle, is directly innervated by sympathetic nerve fibres which are concerned with muscle tone.

INFLUENCE OF DRUGS ON THE AUTONOMIC NERVOUS SYSTEM

Langley demonstrated that adrenaline, an extract of the suprarenals, stimulates the whole sympathetic system, and that its action upon any part is the same as the

stimulation of its sympathetic nerves. This is not perhaps surprising when we recall that the suprarenals are unique in that they are innervated directly by pre-ganglionic neurones and that their chromaffin cells are of nervous origin. But is it not a remarkable fact that chance substances, so to speak, should be found which have a more or less specific action? One is almost led to wonder whether the provisions of nature have been so arranged that every pharmacological agent has its specific antidote awaiting discovery.

Drugs act upon the autonomic system in a variety of ways. Thus, while adrenaline stimulates the sympathetic, ergotoxine paralyzes its motor fibres. Again, while pilocarpine, physostigmine, and choline stimulate the parasympathetic, atropine paralyzes its terminations. But the influence of drugs is more complicated than these general statements would suggest, for their effects are less specific than those of adrenaline, and, as Langley pointed out, organs innervated by the sympathetic may be influenced by substances which stimulate the sympathetic, even after they have been deprived of their nerve supply.

Laboratory investigations upon the selective action of drugs have served to clarify the physiology of the autonomic system, and have provided valuable therapeutic indications. Is it not possible, conversely, that the influence of drugs of known mode of action may throw light upon the aetiology of clinical conditions in which their beneficial effect has been definitely proved? For instance, does the benefit derived from belladonna in cases of Parkinsonism justify any conclusions as to the nature of the rigidity?

SOME CLINICAL ASPECTS OF SYMPATHETIC-PARASYMPATHETIC IMBALANCE

The conception of antagonism between the sympathetic and parasympathetic nerve supply led Eppinger and Hess in 1909 to introduce the terms vagotonic and sympathetico-tonic with which to designate individuals whose characteristics suggest excitability of the vagus on the one hand or of the sympathetic on the other. Their conclusions were based partly on the observation that atropine does not paralyse the sympathetic in individuals who respond strongly to adrenaline and vice versa, and partly on general clinical considerations. The vagotonic individual is described as reserved, phlegmatic, and "cold-blooded"; he has a slow pulse and a low blood pressure, he sweats readily, has clammy hands, is prone to suffer from spastic constipation and hyperchlorhydria, his sugar tolerance is high, etc. On the other hand, the subject of sympathetico-tonia is impulsive and excitable, and has a high colour, a fast pulse, a warm skin, etc. Although these clinical pictures are not so clean-cut as Eppinger and Hess depicted them, we can all probably recall individuals who conform to one or other type. One is reminded in this connexion of the "humours" of our forefathers and of the graphic descriptions of the diatheses in my student days. Medicine has of recent years become so scientific in its outlook that less importance is perhaps attached to unexplained clinical entities and impressions than was formerly the case. Some day, perhaps, when we know more of the factors which predispose to disease, the characteristics of the individual may be summed up in terms of endocrine preponderance and vagosympathetic balance. I shall leave the problems of local sympathetic-parasympathetic imbalance to the speakers who are to follow.

EMOTIONAL REACTIONS AND THE NEUROSES

We are all familiar with emotional reactions as they occur in ourselves and others. Darwin's classical descriptions in his *Expression of the Emotions* are no doubt well known to many of you. The manifestations of joy, sorrow, fear, rage, shame, etc., are here vividly depicted,

as they are too in the works of Crile and of Cannon. The minor emotional disturbances we witness every day. Why is it that one patient presents a rapid pulse, tremulous hands, a flushed face, and, it may be, beads of perspiration on her forehead, while another is quite unperturbed? This state of "fright" must result from an excitable sympathetic system with its secondary endocrine effects. There are many emotional reactions which influence the normal functioning of the individual organs. Originally no doubt these emotional phenomena constituted part of a protective mechanism, but now they fulfil no useful purpose. Indeed, when they become habitual, as they may do by frequent repetition, they are apt to induce a state of self-consciousness, become a source of annoyance, and lead to introspection.

But what is the nature of emotion? The views of Kempf¹⁵ are here of interest. It is generally admitted that the normal sense of well-being is dependent upon the perfect functioning of the autonomic mechanisms, and that when any one of these is disordered we may be aware of a general sense of uneasiness. According to Kempf the reflex activities of an autonomic segment reach consciousness when they attain a certain intensity and constitute a craving which must be satisfied. Thus hunger is satisfied by food, and an injurious stimulus by "fight or flight." Further, these cravings are associated with feelings of fear or anxiety which, if they are not neutralized, persist and interfere with the efficiency of the personality. But these reflexes may be "conditioned," with the result that a stimulus which was primarily indifferent may call forth the response; consequently the original stimulus may not always be obvious. Kempf also believes that if the individual is only partially successful in dealing with a craving of this kind it is suppressed; but when the *ego* is completely successful in dealing with it, so that it does not come into consciousness, it is repressed. In such circumstances the craving is unable to acquire a neutralizing stimulus and the fear or anxiety persists, and, since the repressed effects are continually trying to force the organism to become conscious of their needs, they cause uneasiness. Thus emotion is, according to Kempf, the result of cravings which, being suppressed or repressed, are unable to release the tension by acquiring neutralizing stimuli.

The part played by the emotions and by anxiety, as also by conscious attention directed to the normal autonomic functions, cannot be over-emphasized. Many disorders of health are so produced. Introspection interferes with the normal functioning of the body, for when an individual's attention is concentrated upon his autonomic mechanisms the normal sympathetic reflexes are disturbed. Here the physician plays a prominent part by correcting misconceptions and anxieties and encouraging the patient to occupy his mind with outside interests.

MAY SYMPATHETIC REACTIONS DETERMINE STRUCTURAL CHANGES?

We have seen that individuals vary in their sympathetic-parasympathetic "make-up," and that there is good reason for believing that the manifestations of a general or local autonomic reaction may by repetition become habitual. Hence the question arises, and a very important one it is: May these autonomic reactions lead to structural changes in the tissues? That grief and fear may predispose to disease is generally admitted, and we are all familiar with cases in which exophthalmic goitre and other disorders have developed as a direct consequence of an emotional cause. But do emotional reactions determine physical changes? Do the variations in arterial pressure which occur in the "nervous" individual lead to arteriosclerosis? Is the individual who presents sympathetico-tonic characteristics shorter lived

than his vagotonic brother? Is the peptic ulcer more common in persons of the sympatheticotonic type? Does the excessive use of an organ lead to structural changes in that organ? These are some of the problems which occur to one. The observation of J. Beattie, already referred to, is here of interest. There would appear to be a fruitful field for investigation on these lines.

MORBID ANATOMY OF THE AUTONOMIC SYSTEM

Apart from the new growths which present distinctive histological features little is known of the morbid anatomy of the autonomic system. A variety of appearances have, it is true, been described in the ganglion cells; but, as Nissl indicated many years ago, the histological picture presented by a pathological nerve cell is not distinctive of the process which produces it. Nor have attempts to study the morbid anatomy of disorders, the clinical features of which suggest their dependence upon autonomic disease, so far afforded much information. As Hurst¹⁶ points out, achalasia of the oesophagus—some eighteen cases of which have been recorded in which there was inflammation or degeneration of Auerbach's plexus in the cardiac sphincter—is the only malady definitely known to be due to disease of the sympathetic nervous system. But there must be many others so produced. Those distressing cases of thin blue caecum with a paper-like colon, of which I have seen several instances in otherwise healthy and robust young women, must, one is almost forced to believe, have a similar aetiology. Then again, the muscular wasting and trophic skin changes occurring in some cases of arthritis and the localized atrophy of the adjacent muscles of the thorax seen in some cases of phthisis are difficult to account for unless by structural changes in the autonomic nerve supply. Is it not reasonable to suppose that the autonomic system is liable to be affected by the same morbid processes which attack the voluntary nervous system and other tissues? In 1925 I advanced the view that the muscular dystrophies may be due to an abiotrophy of the sympathetic system.¹⁷ Ken Kuré of Tokio¹⁸ has since brought forward additional evidence in support of this suggestion, for he has shown not only that atrophy of muscle may be produced by sympathetic denervation, but that the histological appearances are similar to those met with in the dystrophies. I suggested further that cases of muscular dystrophy (reported in the literature by recognized authorities) in which recovery had occurred might perhaps be explained by a polyneuritis of the sympathetic, with a consequent distribution of the atrophy similar to that observed in the dystrophies.

CONCLUDING REMARKS

The purpose of this introductory paper has been to indicate some of the more prominent anatomical features and general functions of the autonomic system. I shall have attained my object if I have succeeded in arousing the interest of those of you who profess no special knowledge in a subject of great clinical importance. From the therapeutic standpoint I have emphasized the fact that sympathetic-parasympathetic imbalance accounts for certain attributes in the "make-up" of the individual, and have indicated certain factors which demand consideration in the province of individual preventive medicine. To the many diseases and disorders which have been attributed on clinical grounds to autonomic disturbance—and they are legion—I have made no reference. Among others I may mention Raynaud's disease, the syndrome of intermittent claudication, thrombo-angiitis obliterans, migraine, angina pectoris, vasovagal attacks, spasmodic asthma, excessive sweating, erythromelalgia, angio-neurotic oedema, "trophic" oedemas, scleroderma, unilateral hemiatrophies and hemihypertrophies, lipo-

dystrophy, achalasia of the oesophagus, "congenital" hypertrophy of the pylorus, spastic colon, megalocolon, certain anomalous types of neuralgia, striate rigidity, the hypothalamic syndromes, etc. These are but some of the conditions which at the moment occur to me. Each must have its particular aetiology. What a field for exploration! So long as a disorder is dependent upon functional or recoverable disturbance it comes within the province of the physician, but when it is due to disabling structural changes the possibilities of correction by surgical procedures may have to be considered. The surgeon has already achieved notable successes in the treatment of several of the disorders above referred to (Raynaud's disease, thrombo-angiitis obliterans, congenital megalocolon, etc.), and he will no doubt continue to extend his field of operation. But I would add a final note of warning. The surgical expert, before he interferes—and this applies especially to conditions of sympathetic-parasympathetic imbalance—must be very sure of his diagnostic ground. He must see to it that he attaches due weight to the mental factor in the production of symptoms, and that he is not carried away by his enthusiasm for the niceties of technical procedure.

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RADIOGRAPHIC INVESTIGATION OF LUMBAR AND SCIATIC PAIN*

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No symptom or group of symptoms as those known to the lay public under the terms "lumbago" or "sciatica" may be due to such a diversity of causes. So diverse are the lesions that it is impossible in this discussion, with the short time at our disposal, to cover the whole. The radiographic investigation should always include radiographs of the lumbar and sacral spine, pelvis, and hip-joints, and these should be supplemented by radiographs of other organs or structures according to the indications of the clinician. It is advisable to include lateral radiographs of the lumbar and sacral spine because these may show lesions which would not be suspected from the antero-posterior radiographs. I have recorded the details of a case of aneurysm of the abdominal aorta, the diagnosis of which was made only after a lateral radiograph had been taken. Antero-posterior radiographs of this patient had been made on several occasions because of the persistent

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