THE NATURE OF SYMPTOMS

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PATHOLOGICAL ANATOMY VERSUS PATHOLOGIC PHYSIOLOGY

Present-day medicine owes the superiority which it possesses over the medicine of the centuries past particularly to a number of developments which began in the middle of the last century and which are still going on.

It is impossible for a subject so many sided as medicine to unfold logically. Its progress must follow the direction of those who, at the time, are able to impress the leaders in medical thought most; so an orderly, logical unfolding is not to be expected. The transference of certain disease syndromes to the organs or systems which give origin to them took place early and was the cause which inspired the study of anatomy. It was natural to want to know the difference between a normal organ and the same organ when it was the seat of disease, hence the development of gross pathology.

After the use of the microscope became general it was utilized in the study of both normal and pathologic tissues and histology and microscopic pathology were developed. These structural phenomena seemed so important and so fundamental to the understanding of diseases, and, at the same time, their study became so fascinating, that they early dominated the whole subject of medicine. Clinicians seemed to forget for the time being that their major problem in the practice of medicine was to understand and correct symptoms which are for the most part due to deranged function. The tendency to get farther away from the study of deranged function was increased by the next great development in medicine,—that of the bacterial cause of disease.

The study of the structural changes, particularly those caused by microorganisms and the desire to know every minute phase of bacterial growth and development put microscopic medicine to the fore, and completed the establishment of the hierarchy of structural pathology. Thus the study of structure developed much faster than the study of function. It carried with it elements of accuracy hitherto unknown to clinicians, and so was greatly appreciated and readily accepted. This accuracy was such that it could be duplicated in the study of symptoms neither by the knowledge then at hand, nor by the knowledge since developed; for the study of function is surrounded with much greater difficulties than the study of structure.

In studying function one is confronted by many variables, each of which may modify symptoms of disease. Symptoms may be thus modified by inherited characteristics, physico-chemical differences, endocrine predominances and different states of nervous stability or instability that are found in different patients, or in the same patient at different times. All of this again may be influenced by stimuli which arise either in the physical, emotional or psychical domain. When we realize that every disease process has its psychical side and its basis for emotional upets as well as its physical aspects, we can see how the study of function is beset with great difficulties, and how natural it was for its development to be one of the late accomplishments of medicine.

Now that the study of structural pathology has advanced to a fairly satisfactory state, the development of functional pathology, aided by the methods developed and the facts established, should go on much more rapidly than has been heretofore possible. It is the particular phase of medicine above all others which, at the present time, is demanding our interest and intelligent cosideration.

The one significant fact about the physiologic aspects of medicine, as contrasted with its anatomical or structural aspects, is that in its study our minds are directed largely to the study of the patient who has the disease; to him, too, in both his physical and psychical spheres, for disease affects and is modified by both spheres.

Pathologic changes in tissues and organs cause little concern to the patient who harbors them until they produce departures from the normal function in tissues and organs. These at once assume the importance of symptoms of disease, and effect real and definite changes in the individual's feeling of well being or in his outlook for future enjoyment and accomplishment.

The clinician must ever struggle to understand and alleviate the symptoms which he encounters in his patients. It matters not whether some structural pathology underlies them or not. If function is disturbed, it is the duty of the physician to find out why, in order that he may guard the best interests of the patient.

We shall now attempt to further elaborate this subject by analyzing a few concrete examples, hoping thereby to stimulate thought and further discussion.

IMPORTANCE OF ETIOLOGIC STUDY OF SYMPTOMS

In the fall of 1908, when palpating the chest of a patient suffering from active tuberculosis, I found that certain skeletal muscles were in a state of spasm. I considered

this as probably due to the same mechanism that produces spasm of the abdominal muscles in appendicitis, gall-bladder disease and ulcer of the stomach. But when I endeavored to find out what that mechanism might be, to my great surprise I learned that the explanation of it was not only not common knowledge, but that it was understood by very few.

I then set about to find out how pulmonary inflammation could produce spasm of the muscles of the shoulder girdle. This led me into the study of the nerves of the lung, which, belonging to the vegetative system, had at that time received but scant attention at the hands of physiologists. In fact, physiologists had not yet worked out the reflex paths from the lung. Serious study of the visceral nerves was just beginning to be prosecuted by a few men. Langley, Anderson, Gaskell and Cannon had been experimenting on animals and were able to give account of certain experimental phases of the subject. Eppinger and Hess soon published their conception of Vagotonia; and Higier and Muller followed with a more general description of the clinical phases of visceral neurology. Since then the subject has been occupying an increasing amount of space in literature, but is still far from receiving the consideration that its importance demands.

I found that it was not only this new sign in pulmonary tuberculosis that was not understood, but symptoms in general were simply accepted as entities, without an adequate conception of the reason for their existence.

When I had obtained only meager conception of visceral neurology, I saw how essential its development was to the understanding of clinical phenomena. I recognized that most of the symptoms of tuberculosis could be expressed in terms of disturbance in the vegetative nervous system. I then saw that the same was true of symptoms of other diseases. It seemed clear to me that the symptoms of tuberculosis were caused in one of three ways, and that all of the twenty or thirty common symptoms which accompany pulmonary tuberculosis could have but three etiologic factors; (1) the toxins of the disease; (2) stimuli arising in the inflamed lung and expressing themselves in reflex effects in other structures; and (3) effects produced locally by injury caused by the pathologic process.

It is evident that symptoms falling in groups one and two are definitely caused by disturbances in physiology produced for the most part at some distance from the seat of the disease, and that even those of group three are partly of physiologic origin. The increased permeability of blood vessels which permits of the passage of blood through their walls is a disturbance of normal physiologic function; the increased secretion which results from the increased activity of the mucous glands is caused through nerve stimulation; the pain and muscle tension which accompany pleurisy are evidence of nerve irritation, the cause of stimulation being transferred to the parietal pleura; and many of the symptoms of the so-called "cold" are of physiologic nature. This leaves the rupture of blood vessels; the secretion caused by necrotic foci which carries the bacilli, and the effusion in the pleura or the proliferation resulting from the pleural inflammation only as being distinctly of structural nature.

It is difficult to estimate the total number of symptoms that can be produced by a pulmonary tuberculosis. There may be (1) so many as there are systems affected by the toxins; (2) plus the number expressed in systems and organs which may be brought into reflex connection with the lung through neurons which mediate with the afferent neurons which carry impulses from the lung; and (3) plus those produced locally by the inflammatory reaction. I have personally described some forty reflexes alone, which must be augmented by symptoms of toxic and local origin to make up the total number.

The chief fact that has been impressed upon me by this study is the unity of the human body, and the manner in which activity in one organ or system is correlated through nerves and chemical substances with effects in other organs or systems. It shows the futility of attempting to divide the study and practice of medicine into specialites of this and that organ, or this and that system; for diseases do not limit themselves in that way. If there is any illness in the body anywhere, the whole individual is sick, the only difference is in degree.

There is an emotional factor in every disease, which may cause distinct symptoms of its own through the thalamic centers. So simple a thing as a burned finger may affect every system of the body through the ramification of the sympathetic nerves which in the presence of pain receive stimulation through the thalamic centers. The same is true of tonsilitis, pneumonia, pyelitis, septicemia, or any other disease accompanied by pain, toxemia, or emotional stress; for toxemia and emotional stress, like pain, produce widespread effects through central stimulation of the sympathetico-adrenal system. The whole body is made sick by pain and toxemia and emotions, but in some instances, as in the burned finger, the effects are so slight that very little or no recognizable disturbed function results; but let the lesion be more severe and even a burned finger may at least produce recognizable vasomotor phenomena and inhibitory effects upon appetite and digestion.

As stated above, symptoms of disease are for the most part disturbances in function. Function may be so simple a thing as the taking up or giving off of salts or nutritive

substances by the cells; but such is not a comprehensive statement of the function of a complex and complicated organ or system in the body or of the body itself. Function in this sense means activity in cells, organs or systems by which their normal physiologic purpose of action and correlation of action is expressed for the good of the individual.

Disturbed function then, as we recognize it as an expression or symptom of disease, means a departure in the normal purposeful working of some organ or system, or all organs and systems constituting the body. There is an instability or even a more complete disruption of normal activity brought about in the physiologic functions of the body. This disturbed function may be due to a change in activity in any portion of the neurocellular mechanism which is responsible for normal action. The colloidal make-up of the cell itself; the electrolytes which are necessary to its function; chemical substances such as hormones, toxins and so forth, which reach it through the circulation, or the nerves which transmit stimuli to it; one or all may be at fault.

SYMPTOMS AND THE VEGETATIVE NERVOUS SYSTEM

I have learned to think of symptoms of disease in terms of the vegetative nervous system which supplies the structures which show faulty action. This has to recommend it the fact that all structures of the body are supplied by vegetative fibers belonging to the sympathetic system and many of them have parasympathetic innervation as well. Stimulation or inhibition in these systems means a fairly definite action. Then, too, these two systems of vegetative neurons have each their particular function to perform for the organism. The parasympathetic system is the one that presides over the digestion and assimilation of food and the maintenance of the human body as a working machine; the sympathetics, on the contrary, are composed of those neurons which protect the individual against enemies, prepare him for fight or flight, and help him to make a supreme struggle in the face of danger. The parasympathetics build up the organism; hence are anabolic in action; the sympathetics tear down, hence are catabolic.

In case we have a predominantly sympathetic action in the body, some of the following symptoms will be present; erection of the hairs, sweating, widening of the pupils, salivary inhibition, relaxation of the bronchi, increased pulse rate, elevation of blood pressure, increase of sugar in the blood, and a decrease in the motor and secretory functions of the gastrointestinal tract. A predominantly parasympathetic action is responsible for contraction of the pupil, increased secretion of the glands of the nasal and oral mucous membranes, constriction of the bronchi, slowing of pulse rate, lowering of blood pressure, storage of sugar in the liver, and an increasing of all activity, whether secretory or motor, throughout the gastrointestinal canal.

By knowing these various effects one may readily classify disturbed function in organs which have double innervation according to the expression of activity of one or the other system of vegetative nerves without necessarily implying that the cause is in the nerve itself; for it may be in any component of the neurocellular mechanism. The effect, however, is more or less distinctly a hyper- or hypofunction, and so may be thought of in terms of the vegetative nerves supplying the structure.

Thus, increase in the number of heart beats means a sympathetic effect, while a slowing of the heart is a parasympathetic effect. Dilatation of the pupil is a sympathetic effect; constriction, a parasympathetic. Asthma consists of contraction of the bronchial musculature and an increase in the secretory activity of the bronchial glands, together with an exudation in the tissues which may be considered as a part of an increased vascular permeability, all of which is a part of a parasympathetic picture; and, so on.

ANALYSIS OF SYMPTOMS APPEARING WITH CHANGES IN BLOOD SUGAR LEVEL

Now, as illustrating the value of such a mode of analysis, let us take, as an example, a condition of equilibrium maintained in the body such as the sugar level of the blood.

The sugar of the blood is maintained at a fairly constant level under many and varying conditions and circumstances of health. When large quantities of sugar—too large for immediate utilization—are consumed, the excess is stored in the liver in the form of glycogen, to be given out in the natural course of events, as needed by the muscles; or as artificially called for after insulin has depleted the blood supply, as is seen in experimental hypoglycemia.

By studying the effects of insulin upon this store we can see a delicate physiologic balance. When insulin is given in such quantities as to reduce the glucose below 70 mgs. per 100 c.c. of blood, the hypoglycemic state may supervene. This state is met by a defense reaction on the part of the body brought about by the sympathetic nerves and the adrenal bodies coming to the rescue and forcing sugar out of its storehouse into the circulation. The rapidity of the pulse, the dilatation of the pupils, and the profuse sweating are further evidence of increased sympathetic action. If the sympathetico-adrenal system fails to restore the necessary amount of sugar to the blood and the amount of blood sugar continues falling, convulsions may appear. Convulsions stimulate still further the sympathetico-adrenal system and if the liver still contains an ample store of glycogen, the reaction may be able to force sufficient glucose into the blood stream to re-

lieve the hypoglycemic state, and with it the convulsions; but if not, death may ensue.

Stimulation of vagus fibers supplying the pancreas causes an increase in insulin output, which produces a parasympathetic effect which again is met and counteracted by the sympathetico-adrenal mechanism, as previously mentioned.

ANALYSIS OF SYMPTOMS ACCOMPANYING TOXEMIA

Another very interesting study from the standpoint of symptoms is that of the toxic state. Toxemia is followed by a chain of many symptoms such as fatigue, chill, aching, fever, loss of strength, increased nervousness, insomnia, rapid heart action, dilatation of superficial blood vessels, sweating, dry mouth, lack of appetite, lessening of the secretions and the motor functions of the gastrointestinal canal, increased respiratory effort and either a leucopenia or a leucocytosis, according to whether the white cell regulating mechanism is depressed or stimulated.

If we think of these many symptoms as individual expressions of physiologic disturbance, we are confused, for individually they fail to give us any concrete picture of what is going on as a result of disease. If, however, we think of them as being symptoms called forth by a toxic state, we have made some progress; but are still far from having any definite intelligent grasp of what they mean. But if we think of them as being a part of the manner in which the body expresses its attempt to defend itself against injurious poisonous substances which are brought to it by an infection or by other means, a part of the defensive mechanism which has been called out, then we have a definite method of approach, but one which still requires a great deal more information before we can offer an explanation of their cause.

In attempting to account for these symptoms and make them understandable, the first thing that must impress a student of visceral neurology is that they are expressions of stimulation of the sympathetic nervous system and its inseparable adrenal gland.

This toxic state is very apt to be characterized in terms of temperature which is only one of its most prominent expressions. What should come to one's mind is that the toxic state calls out a general response on the part of the sympathetico-adrenal system. The thyroid, too, must be considered as a part of this system. This is the particular system which has for one of its chief functions the preparation of the individual for physical defense and the sustaining of him during the period of struggle. So we now get a closer view of what our toxic symptoms mean. They are an expression of certain states which are brought about in the body in order to defend it against some poisonous substance; in the case of bacterial disease they are expressions which accompany the specific immunity response, and probably are necessary to its establishment.

This toxic reaction of the body differs somewhat but only in details of expression from the defense against outward foes. The difference seems to be due to the fact that the effect is released from within by a toxic chemical element. The general peripheral expression, however, is the same, consisting of those effects which are produced by stimulation of the sympathetico-adrenal system.

Cannon and his co-workers have shown that the bodily states which are called out by such major emotions as fear, anger, grief, preparation for fight or flight, and pain, produce their effects by stimulating certain nerve stations in the thalamus; so, too, because of the similarity of symptoms we must suspect this part of the brain to be the recipient and distributor of impulses in defense of the body in toxic states. The expression of anger and rage is a primitive function, likewise the function of defense was necessary and exercised before the cerebral cortex was developed; and while the cortex can inhibit to a certain degree some of the emotions which call out physical defense, yet such function is largely reflex in character and put into effect without volition. The defence against toxins seems to be wholly out from under cortical domination and in this way differs from physical defense.

With present knowledge, we are not in a position to state definitely that toxic effects may not be expressed in the cells of the body generally, aside from those produced through the sympathico-adrenal system; but from analyzing the effects shown, it seems quite clear that there is not only a lack of stimulation, but an actual inhibitory effect exerted by toxins on those structures which are activated by the parasympathetic system, as may be inferred from the effects shown on the heart, the salivary, gastric, intestinal, pancreatic and biliary secretions, on hunger and digestive peristalsis and on the bronchial musculature and glands. As a part of the toxic syndrome all of these systems are made conspicuous by the depression in activity which characterizes them. This indicates that toxic effects are expressed in sympathetic syndromes in the same manner as such major emotions as fear, anger, rage, pain and defense against outward foes, and such minor emotions as those caused by worry, discontent, unhappiness and pessimism.

The body's reaction to toxins, whether bacterial or nonbacterial, is always shown in the same way. Infections caused by pathogenic bacteria of all kinds are accompanied by a response which is qualitatively the same whether they be diphtheria bacilli, typhoid bacilli, streptococci, tubercle bacilli, or

the causative germs of measles and smallpox.

It was suggseted by Vaughn several years ago that there are two factors in bacteria which produce reaction; the one specific and capable of stimulating the immunity mechanism of the host; the other toxic and responsible for the toxic reaction. Further evidence sustaining such a conception has recently been adduced in the study of the tubercle bacillus in which it has been shown that a certain saccharid fraction which is attached to the protein molecule is responsible for highly toxic effects. Vaughn thought he had proved that the toxic element was not a carbohydrate, but more recent methods of study seem to indicate that the toxic element in tuberculoprotein at least is. Be this as it may, the usually recognized rise of temperature with malaise, aching, rapid pulse, and decreased activity in the glandular and muscular functions of the gastrointestinal canal consistently accompany immunity responses of the body to infections.

The toxic reaction may bring about conditions advantageous to specific defense even though not caused by specific immunizing substances. As a result of the reaction the patient's resistance to toxins is undoubtedly increased; from the rise in temperature the physico-chemical reactions of the body are quickened, and the immunity mechanism is permitted to act with great efficiency; and at the same time, the increase in the temperature of the tissues makes them unfavorable for the growth and multiplication of microorganisms.

It must be evident to the student of clinical disease that there is not a single symptom in the group of toxic origin that is pathognomonic of any particular disease. Measles, whooping cough, tonsillitis, typhoid fever, tuberculosis, pneumonia, malaria, and all other infections show similar toxic reactions, differing only in degree. The same temperature and the same other symptoms may be produced by the injection of egg-white, Witte's peptone, or other protein substances. The curve of the temperature may be made to imitate the curve found in any of these infections by varying the dosage, in size and interval.

The important point regarding the toxic reaction is that it represents general nerve disturbance with a preponderantly peripheral effect expressive of stimulation of the sympathetic system. The same general symptoms are also found in such nervous states as neurasthenia and psychasthenia, also in many conditions significant of endocrine imbalance. Even a slight rise of temperature may be present in individuals who have an unstable nerve balance. Realizing that eighty-five per cent of the heat of the body is thrown off through the skin, and further realizing that a temperature curve only represents the balance between heat production and heat elimination, one may readily see how an individual might show a slight elevation of the temperature curve, if the vasomotors of his skin were slightly stimulated, even though there were no toxins set free in the body to produce increased heat reaction.

It must be evident then that the members of the toxic group of symptoms are not of particular diagnostic worth, when considered apart from symptoms of the reflex and local groups. The temperature curve, however, varies according to the size and the frequency of the dose of toxins absorbed, which differs with different diseases to such an extent that the older clinical observers learned to associate definite types of temperature with definite diseases. Thus they recognized a certain type of temperature for typhoid fever, another for malaria, and still another for tuberculosis, et cetera.

A STUDY OF REFLEX SYMPTOMS

No group of symptoms is more fascinating for study than those of a reflex nature. Every organ is supplied by sensory or afferent nerves, and if it should become the seat of an inflammatory process, or if for any other cause, it should give origin to stimuli of undue strength, it has within it the possibility of originating reflexes. These reflex effects, if mild, may be dissipated without calling out any demonstrable changes in function of other organs or tissues; or, if severe, may cause serious and widespread disturbances in function.

For the purpose of producing reflex effects, every efferent nerve in the body may be brought into contact with impulses which are carried centralward over any afferent neuron, as must be evident in the universal spasms set up in the animal whose synapses have been affected by strychnin poisoning. A touch on any part of the body, a noise or a sight of something exciting may throw the animal into general convulsions.

Afferent nerves in internal viscera are not so necessary for defense as they are on the surface of the body which is exposed to constant danger of injury. The protected situation of the viscera does not call for quick response on their part to such stimuli as those of a cutting, burning, tearing or pinching nature to which the superficial structures of the body are exposed. Such stimuli as these, in the other hand, are commonly met by exposed portions of the body and require that special receptors for them be distributed everywhere over its surface in order that it may quickly respond with defensive reaction and avoid injury. Nevertheless, the viscera are supplied by afferent fibers, though relatively much fewer in number, which carry impulses back to the central nervous system and transfer them to other neurons through which action may be brought about. The effects so produced depend upon the severity of the stimulus, the frequency of its repetition, the time over

which it extends, and the function of the neuron to which the stimulus is transferred. The effect may be contraction of a muscle; it may be a secretory effect; it may be a sensation; or, if the injury lasts a long time, it may be a trophic effect.

Many reflex effects are physiological and take place in conditions of normal health. A certain and important control of body function is due to the correlation of activity of separate and even widely separated structures, and this control is brought about normally by impulses which are picked up by the sensory organs in the tissues and carried centralward by afferent neurons and transmitted within the central nervous system to neurons which affect activity in the tissues of their peripheral distribution. In case of disease or injury of any of these organs the normal reflex pathways are made to carry the abnormal impulses generated by inflammation or other irritation, and, instead of there being a mild stimulation effecting a benign influence, there is an unusual stimulation with tendency to disturb and distort function; and, if continued sufficiently long, to work permanent injury to the organism.

These reflex effects become an important cause of symptoms in many diseases. Any disease which causes an inflammatory process in the tissues may cause reflexes. Hence reflex symptoms come to be an important part of all inflammatory diseases which are localized in internal viscera. Reflex symptoms are also caused without inflammation being present whenever abnormal stimulation of afferent neurons takes place. In this way pain and cramps may result from abnormally strong peristaltic action in different portions of the alimentary tract.

Little progress can be made in the understanding of the clinical manifestation of such pathologic processes without a working knowledge of visceral neurology.

By knowing the innervation of the organs, and the segments in the central nervous system in which the majority of the impulses are most apt to form reflexes, and then by understanding the laws under which reflexes normally take place, as well as the laws which govern their variation, one will find that reflex symptoms of disease take on a new and definite meaning.

REFLEX EFFECTS FROM INFECTED TEETH

A toothache, if one understands reflex relationships, may become a very interesting study. During the toxic stage symptoms of sympathetic stimulation are prominent, being caused by both the toxins and the pain. But aside from that the reflex effects are very interesting. The teeth are supplied with sensory fibers by the Vth cranial nerve. The pain of toothache may be expressed in a wide area; first, in and about the tooth itself, and, second, over the superficial sensory fibers of the Vth nerve, particularly of the maxillary portion in case of an upper tooth and the mandibular portion if it is a lower tooth. Reflex lachrymation may be caused, particularly if an upper tooth is involved, by the impulse being carried centralward and then being transferred to the VIIth cranial nerve which supplies the lachrymal glands. Likewise, an increase of nasal secretion through the VIIth supplying the nasal mucous glands; and sometimes salivation through the VIIth and IXth nerves. Often, too, reflex nausea and vomiting are shown on the part of the gastrointestinal canal. Locally pus formation and exudative phenomena appear.

ANGINA PECTORIS

The symptoms of angina pectoris are also extremely interesting. The pain in the upper portion of the chest on the left side and in the left arm is the best recognized of all symptoms because it overshadows all else. It is regularly expressed in the Ist, IId and IIId dorsal sensory nerves, on the left side. These arise from the first, second and third thoracic segments of the cord. The heart receives its sympathetic nerve supply from the left half of the upper five or six thoracic segments; the ventricle particularly from the upper three. Since it is the natural thing for afferent impulses to be transferred to efferent nerves in the same segment which they enter, and on the same side of the body, the nerves arising from the upper thoracic segments and particularly those arising from the left half of these segments are the nerves which would be expected to express pain in case of heart lesions.

Sometimes, however, the pain is transferred upward into the neck, being expressed in the cervical sensory nerves and sometimes across to the right side of the body. All of this occurs, however, according to a definite law in physiology which governs the spread of reflexes upward or downward in the cord. This transference could probably occur either upward from the impulses which reach the cord in the upper thoracic segments or downward from those reaching the central nervous system in the medulla.

Spastic contraction of the muscles also occurs in angina, being produced through the motor nerves which correspond in origin to the sensory nerves which show pain.

There is also a reflex increase in respiratory effort, reflex effects in the gastrointestinal canal and reflex disturbance through the circulatory system, all of which follows regular paths over which physiologic impulses flow in conditions of health.

PULMONARY TUBERCULOSIS

The lungs offer an excellent opportunity to study reflex symptoms. They do not show pain like the hollow viscera such as the heart, stomach, intestine, gall-bladder, gall ducts and ureter, which have contraction as a part of their normal function; but by furnishing a large area which may be involved in the inflammatory processes, they

furnish the ideal condition for originating many afferent impulses, particularly when infected with a widespread chronic inflammation such as is found in tuberculosis.

I have been able to suggest the paths for about forty reflexes from the lung, and have been able to prove most of them. The lungs being supplied by both the sympathetic system and the vagus of the parasympathetic system, and each of these systems having afferent neurons associated with them offer two distinct routes over which afferent impulses may travel; that over the sympathetic route goes to the upper five or six thoracic segments; and that over the vagus route to the medulla.

The afferent impulses which reach the central nervous system over the sympathetic route are transmitted up into the cervical segments of the cord, where they both mediate with motor and transfer their impulses to sensory nerves going to the skin, subcutaneous tissue and muscles which arise from that region, particularly the third, fourth and fifth segments. These produce spasm of muscle, changes in sensation and degeneration of tissues. They likewise transfer impulse to sympathetic efferent neurons in the upper thoracic region which cause reflexes in the viscera.

The afferent impulses which course centralward with the vagus are transferred in the medulla and midbrain to other cranial nerves, and produce widespread motor, secretory, trophic and sensory reflexes throughout the cranial region and in the viscera supplied by other branches of the vagus. Rasmussen and Larsell believe that the reflexes in the cervical portion of the cord also may be due to impulses transferred downward into the cord from the medulla. Through the vagus, such important structures as the larynx, heart and gastrointestinal tract, with the pancreas and liver, are affected.

The following four tables will show how widely spread the reflex effects from an organ may be and will serve as a paradigm for studying other viscera.

TABLE I. PULMONARY REFLEXES IN SKELETAL STRUCTURES IN WHICH AFFERENT STIMULI COURSE CENTRALWARD OVER THE SYMPATHETICS AND EFFERENT OVER THE CERVICAL SPINAL NERVES PRINCIPALLY CIII, CIV AND CV.

I. **Motor reflexes when the disease is active, as follows:**
   1. Spastic contraction of the muscles of the shoulder girdle (sternocleidomastoideus, scaleni, pectorales, subclavius, trapezius, levator anguli scapulae, rhomboidei) and the crus and central tendon of the diaphragm.
   2. Limited motion of the half of the thorax, on which the diseased lung is found, through reflex spastic contraction of the sternocleidomastoideus, scaleni and subclavius above, and the crus and central tendon of the diaphragm below.

II. **Trophic reflexes when the disease becomes chronic, or has healed, as follows:**
   1. Atrophy of the muscles of the shoulder girdle.
   2. Atrophy of the skin between the second rib and angle of the jaw anteriorly; and the spine of the scapula and the base of the skull posteriorly.
   3. Atrophy of the subcutaneous tissue between the second rib and angle of the jaw anteriorly; and the spine of the scapula and the base of the skull posteriorly.

III. **Sensory reflexes as follows:**
   1. Altered sensation, both superficial and deep, usually in the form of discomfort or aching rather than sharp pain; noted both when the disease is acute and chronic.
   2. Vasomotor phenomena producing flushing of the ear through the 3rd cervical sensory nerve, when the disease is active.

TABLE II. PULMONARY REFLEXES IN SKELETAL STRUCTURES IN WHICH AFFERENT STIMULI COURSE CENTRALWARD OVER THE PARASYMPATHETICS (VAGUS) AND EFFERENT OVER THE VARIOUS CRANIAL NERVES.

I. **Motor reflexes when the disease is active, as follows:**
   1. Spasm of the sternocleidomastoideus and trapezius, through the spinal accessory. (Possibly spasm of all muscles of the shoulder girdle, through cervical nerves, as suggested by Rasmussen).
   2. Probably motor reflexes in the facial muscles through the facialis and trigeminus, since these atrophy when the process becomes chronic.

II. **Trophic reflexes when the disease becomes chronic or has healed, as follows:**
   1. In the facial muscles through the facialis and trigeminus.
   2. In the tongue, causing atrophy and deviation toward affected side, through the hypoglossus and lingual.

III. **Sensory reflexes as follows:**
   1. Headache, face ache, etc., through the sensory branches of the trigeminus, both when the disease is acute and chronic.
   2. Vasomotor phenomena producing flushing of the face, through the sensory fibers of the trigeminus when the disease is active.

TABLE III. VISCERO-VISCERAL PULMONARY REFLEXES IN WHICH BOTH AFFERENT AND EFFERENT STIMULI COURSE OVER THE SYMPATHETICS

I. **Motor and secretory visceral reflexes when the disease is active, such as:**
   1. Dilatation of pupil.
   2. Inhibition of motor and secretory activity in gastrointestinal canal.
   3. Spasm of sphincters in gastrointestinal canal.
   4. Increased heart action (tachycardia.)
   5. Probably decreased motility and decreased secretory activity in ducts and glands of gallbladder, liver and pancreas, although not readily proved.

II. **Probably trophic reflexes in structures subject to reflex action, when the disease is chronic or has healed.**

TABLE IV. VISCERO-VISCERAL PULMONARY REFLEXES IN WHICH BOTH AFFERENT AND EFFERENT STIMULI COURSE OVER THE PARASYMPATHETICS.

I. **Motor and secretory visceral reflexes when the disease is active, such as:**
   1. Increased secretion in the mucous glands of the nasal and naso-pharyngeal mucous membranes (catarrh) through the VIIth cranial nerve.
   2. Disturbances in the motility of the vocal cords through the superior and inferior laryngeal nerves,
   3. Probably motor reflexes in the lingual muscles through the hypoglossus since this atrophies when the disease becomes chronic.
   4. Slowing of heart through the vagus.

5. Increased motility and increased secretory activity in gastro-intestinal canal through the gastric and intestinal fibers of the vagus, favoring appetite and digestion.
6. Probably increased motility and increased secretory activity in the ducts and glands of liver, gall-bladder and pancreas, favoring digestion, although not readily proved.
7. Cough, the afferent impulse being carried over the vagus to a center from which afferent impulses go out producing action in the abductor muscles of the larynx over the inferior laryngeal nerve, and in all expiratory muscles through the various spinal nerves; and simultaneously producing inhibition of action in the adductor muscles of the larynx and the muscles of inspiration.

II. **Trophic reflexes in structures subject to reflex action when the disease is chronic or has healed.**
1. In the tissues of the nasopharynx through the facialis.
2. In larynx through superior and inferior laryngeal nerves.
3. Probably in heart, gastrointestinal tract, liver and pancreas, though not readily proved, through vagus.

III. **Sensory phenomena.**
1. Laryngeal irritation through the superior laryngeal nerve.

These examples will serve to show how reflex effects may be unraveled by the clinician if only he will bear in mind the paths through which the visceral nerves have the power to correlate activity in different organs and structures.

The endocrine glands also come into the picture and take part in producing definite and well recognized syndromes at times.

Symptoms may originate, or may be changed, when established, by alterations in the chemical control of the body. A disturbance in the normal products of the various glands of internal secretions causes certain syndromes which are at times so definite that they can be recognized with ease and have come to be recognized as the clinical picture of increased or decreased function. Aside from this, each organ or function which depends on a normal secretion of some gland for its stability is thrown out of its usual mode of reaction under endocrine dysfunction and so effects symptoms that may be expressed in states of disease.

SUMMARY

(1) Pathologic physiology must be studied as intensely as pathologic anatomy, if we are to understand the symptoms of clinical disease.

(2) The true value of symptoms may be assessed only by classifying them etiologically.

(3) The relationship of symptoms to the vegetative nervous system is discussed.

(4) An etiologic classification of symptoms of infectious diseases involving important organs is discussed as follows:

(a) Group I. **Toxic symptoms** which are expressed generally throughout the body, but particularly throughout the sympathetico-adrenal system.

(b) Group II. **Reflex symptoms** which are produced by irritation of afferent nerves supplying a given organ which carry the impulse centralward and transmit it to some efferent neuron for action.

(c) Group III. **Local symptoms produced** by the inflammatory condition in the organ itself.

(5) The etiologic classification of the symptoms which present in a few widely different clinical conditions is discussed.

(a) Symptoms appearing with changes in blood sugar level.

(b) Symptoms accompanying toxemia.

(c) Symptoms accompanying acute abscess of teeth.

(d) Reflex effects from angina pectoris.

(e) Reflex effects from pulmonary tuberculosis.

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