THE DIAGNOSIS OF NERVOUS DISEASES I.

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To no other branch of medicine can the heuristic approach be applied more profitably than to the subject of neurology. And yet the diagnosis of nervous disease is commonly considered obscure and difficult. The nervous system represents to many a confused mass of nuclei and tracts, and diagnostic principles are forgotten in the attempt to memorize a bewildering variety of syndromes. The protocols of neurological diagnosis might profitably be restated.

I. The form and functions of the nervous system

By the middle of the last century a great deal was already known of the anatomy of the nervous system. Its functions were still ill-understood. In general, the cerebral hemispheres were considered to be the seat of the 'will' and of volition, whilst the brain stem and spinal cord were loci of motor activity. Epilepsy, for instance, was thought to be of medullary origin. The rise of the experimental school, heralded by Flourens and Magendie, with the application of physiological method to the study of nervous function, produced brilliant results. Valuable as these findings have proved, however, more valuable still were the experiments made by disease on the nervous system. Indeed, it is a clinician, Hughlings Jackson, of the London Hospital, to whom we owe the conception of the organization of the nervous system on which are based the principles of neurological diagnosis.

In his Croonian lectures of 1884 on 'The Evolution and Dissolution of the Nervous System,' he postulated that there is a passage

- (i) from the lowest centres, which are well organized at birth, to the highest centres, which gradually evolve during life,
- (ii) from the most simple to the most complex, and
- (iii) from the most automatic to the most voluntary.

Disease produces a dissolution of function in the reverse order—thus, in a hemiplegia, the movements most impaired are the most voluntary, whilst the spasticity, increased reflexes, and flexion withdrawal reflex (extensor plantar response) are evidence of function of lower centres. There is a 'release' of these lower centres, which function in their relatively simple, archaic fashion.

These conceptions were his greatest contribution, but he was also the first to teach that a diseased part cannot have an action in itself. In cerebellar disease, for instance, the ataxia, atonia and dysequilibrium are not examples of cerebellar actions, but what actions are like when the cerebellar influence is impaired or removed.

Hughlings Jackson still dominates neurological thought and his formulations illumine every case of nervous disease. To apply these principles, however, it is necessary to understand the pattern of the nervous system. Again, instead of memorizing a profusion of detail, of nuclei and tracts, it is broadly necessary to consider the four main components of the nervous system:

- (a) The motor systems.
- (b) The sensory systems.
- (c) The integrative systems.
- (d) The autonomic systems.

(a) The motor systems

The motor neurone lying in the anterior horn of grey matter in the spinal cord is the 'final common path' for motor impulses. In the words of Sherrington it is 'a convergence point about which summate not only excitatory processes fed by converging impulses of varied provenance arriving by various routes, but also inhibitory influences of varied provenance and path.'

The functional state of the motoneurone indexes the net result from these two processes of inhibition and excitation. The pathways for these impulses may be segmental, or suprasegmental, in level—for the former impulses from muscles, tendons and joints; for the latter impulses from cerebral hemispheres (broadly speaking, pyramidal); from basal ganglia and brain stem nuclei (extrapyramidal). The dissolution of segmental pathways removes either excitatory or inhibitory stimuli playing on the motoneurone, clinically resulting in flaccidity, hypotonia and absent reflexes. The dissolution of suprasegmental motor pathways likewise removes or impairs their influence on the motoneurone. Depending on the pathway affected, spasticity, involuntary movements or rigidity may result.

Fasciculation and fibrillation. The word fibrillation is somewhat loosely employed to describe spontaneous twitching of muscle fibres. The work of Denny-Brown and Pennybacker has shown, however, that, in general, these movements may be of two types. The first, occurring in conditions producing hyperexcitability of the motoneurone (notably progressive muscular atrophy) is a rather coarse twitching of muscle fasciculi and is termed fasciculation. It is produced by regularly periodic discharges of single impulses from the motoneurone. The second occurs in denervated muscles and is a 'confused medley of small twitches.' It constitutes true fibrillation. It can only be observed where muscle substance is not obscured by overlying structures, in such situations as the tongue and the first dorsal interosseous muscle. It results from heightened excitability of the sarcolemma to acetylcholine.

The two types of twitching may thus occur in the same patient or be indicative of quite separate conditions.

In circumstances of fatigue or excessive loss of sodium chloride, involuntary twitches occur, resulting from small bursts of fascicular contraction.

(b) The sensory systems

Taken in its largest meaning sensation is the first manifestation of nervous organization. The all-important awareness of the environment is mediated by three main sensory systems:

- (i) The exteroceptive, with end organs in the skin and specialized sensory endings such as the eye, ear and nose.
- (ii) Proprioceptive, with its outposts in muscles, tendons, joints and labyrinth.
- (iii) The interoceptive system, concerned with impulses from the viscera and internal organs.

The regrouping of sensory modalities that occurs throughout the neuraxis is of diagnostic importance. For instance, all impulses capable of arousing the sensation of pain come together in the spinal cord to form the dorsal spinothalamic tract. The pathways for tactile impulses travel in both the posterior columns and in the ventral spinothalamic tract, while postural appreciation and vibratory impulses are carried in the posterior columns. At the pontine level the spinothalamic tract joins the main afferent tract, the mesial fillet, which then carries all impulses mediating 'conscious' sensation from the opposite side of the body.

The thalamus is a relay station to the cortex for both sensory impulses travelling by the mesial fillet and for impulses from the cerebellum. In addition, for the first time, certain impulses enter into consciousness, producing crude and elementary sensation. The thalamus is not concerned with sensory discrimination, which is a cortical function. Pain, temperature and gross movements are recognized, associated with 'crude emotional feeling.'

The sensory cortex is not concerned with the crude recognition of touch and pain, heat and cold. It is responsible for the appreciation of spatial relationships, for discrimination and integration. Clinically the tests employed are the recognition of compass points, of the shape and size of common objects (stereognosis) and of tactile localization.

(c) *The integrative systems*

The anatomical and physiological study of the units which comprise the nervous system has reaped a rich, albeit, still limited, harvest. Limited, because the nervous system functions as a whole, and a knowledge of these integrative processes is still elementary. Mental experience in particular cannot yet be interpreted by physiological methods. However, by current methods, an understanding has been gained of some of the functions of two great integrative systems, the cerebellum and the cerebral cortex.

The cerebellum. Sherrington aptly termed the cerebellum 'the head ganglion of the proprioceptive system.' The effects of disease are well known, cerebella ataxia, hypotonia, and disturbance of posture, but it is impossible at the moment to dogmatize on the functions of this structure, beyond the general statement that it 'greases the cogs,' as it were, and produces smooth and co-ordinated motor activity. Its important connections through the pontine nuclei with the cortex, especially with the frontal lobes, supplies information of the background of postural contraction, upon which volitional motor acts are superimposed.

The cerebral cortex. Although the work of Hughlings Jackson laid the foundations of cortical localization, the broad sweep of his intellect transcended a slavish adherence to the doctrine of 'the patterned cortex.' Whilst recognizing the dominance of certain functions in different areas of the brain, he always regarded the brain work as a whole. However, for clinical purposes it is necessary to know the functions of these dominant areas, as they are understood at the moment.

The frontal lobe consists of three portions, the motor area, the premotor area and the frontal association area. Volitional movements are represented in the motor area from above downwards, roughly in the sequence: foot, knee, hip, shoulder, elbow, wrist and hand, face and tongue. The bladder, rectum and foot are represented on the mesial surface of the hemisphere. The motor area is so extensive that a lesion may affect only one limb—producing a cortical monoplegia.

From the premotor area, which lies anterior to the motor area, arise certain extrapyramidal fibres, primarily concerned with postural

adjustments of the skeletal musculature, but also capable of mediating certain deep-rooted volitional synergies. Apraxia, tonic innervation, forced grasping and groping may result from lesions of this part of the brain. In addition, the posterior part of the second frontal convolution is a locus for conjugate ocular movements.

The frontal association areas are incompletely understood as yet, but lesions here produce changes in personality and behaviour.

The parietal lobe receives sensory impressions from the thalamus and, in general, the parts of the body are represented in the same order as in the motor cortex. The sensory cortex is concerned with gnosis—'the recognition of the position of the limbs in space, the appreciation of movement, and the recognition of its direction and range, as well as the appreciation of weight.' (Head). The angular gyrus is particularly concerned with the recognition of visual symbols.

The temporal lobes are believed to be the cortical centres for hearing, auditory stimuli being received by both hemispheres. Thus a cortical lesion of one temporal lobe will not produce deafness. If the lesion is in the left hemisphere, however, word deafness may occur. The uncinate gyrus is concerned with smell and taste appreciation and a lesion here may give rise to olfactory and gustatory hallucinations.

The occipital lobes are concerned with visual function, the visual fields being represented in the contralateral hemisphere, mainly around the calcarine fissure. On the outer surface of the occipital lobe is a visual 'association' area, concerned with spatial orientation and the recognition of visual symbols.

Speech. Man has reached his position of superiority in the animal world owing to his development of manual dexterity, and his manipulation of certain symbols collectively known as language. Marks, sounds and gestures have come to be substitutes for objects and concepts and the integration of these symbols has come to reside largely in the so-called dominant hemisphere. According to the site and size of a lesion of this hemisphere, more or less disturbance of speech will result.

The subject is necessarily vast and complex, but for clinical purposes, it may be somewhat simplified on a rather arbitrary, anatomical basis.

Motor dysphasia results from a lesion of the left inferior frontal convolution in a right-handed person. It is a loss of the power of speech, a defect in the higher executive mechanisms.

Dyslexia, or word blindness—a failure to recognize visual symbols—results from a lesion of the left angular gyrus—articulation being unaffected.

Word deafness is a failure to recognize the spoken word and is found when the superior temporal convolution is affected. There may be great volubility, but the failure to recognize the spoken word produces a mass of meaningless jargon. This is termed paraphasia, or jargon aphasia.

Finally, lesions of the left supramarginal gyrus produce impairment of all the elements of language, a global dysphasia.

(d) *The autonomic system*

The systems described so far have been concerned with the reaction of the organism to the external environment. The autonomic system, on the other hand, has to do with the 'milieu intérieure,' its two divisions working reciprocally.

The sympathetic system arises from the lateral horn of grey matter in the thoracolumbar cord, whence axones pass to the ganglion chains, or paravertebral plexuses, and thence to the internal organs. It is thrown into action during emergencies, tends to mass discharge and, in the vivid phrase of Cannon, prepares the animal for 'fight or flight.'

The parasympathetic system originates in the brain stem, in particular, associated with the third, seventh, ninth and tenth cranial nuclei and from the sacral cord, the second, third and fourth segments being concerned. The synapses are found in the viscera themselves and in contradistinction to the mass discharge of the sympathetic system, the parasympathetic discharges discretely. The cranial outflow is secretory to salivatory, gastric and pancreatic glands, motor to smooth muscle of bronchi and alimentary tract and inhibits cardiac function. The sacral outflow

is responsible for emptying of bladder and rectum and for erection of the penis.

Connected with the segmental mechanisms by both afferent and efferent pathways are two main suprasegmental organizations—the cerebral cortex and the hypothalamus. Present knowledge indicates that the motor and pre-motor cortex is largely concerned with autonomic activity and that the hypothalamus is the head ganglion of the autonomic nervous system. It is the general opinion that sympathetic function is located particularly in the posterior part of the hypothalamus and that the middle and anterior cell masses subserve parasympathetic function.

The whole autonomic system is intimately connected with the endocrine organs and, in many cases, it is impossible to separate their functions.

II. The effect of disease on the nervous system

Hughlings Jackson first pointed out that there are both negative and positive effects produced by a lesion of the nervous system. The negative manifested by impairment, loss of function, and the positive by release of lower centres. Thus any neurological lesion may produce:

- (1) Loss or impairment of function—either transient or permanent.
- (2) Abnormal or exaggerated function.
- (3) 'Discharge' phenomena.

Accordingly, signs and symptoms must be assessed in the light of these principles before the question: 'where is the lesion' can be answered.

Neurological diagnosis would be chaotic indeed if a second fundamental did not apply—that many nervous diseases have a predilection for certain parts of the neuraxis. Progressive muscular atrophy, subacute combined degeneration, tabes—many examples come readily to mind.

And finally, disease of the nervous system, as disease elsewhere, is a general biological process, with an important temporal factor. The progress of the disorder may be the decisive diagnostic point.

III. The interpretation of neurological signs

The art and charm of neurology lies in the assessment of the physical findings, 'les faits ne prennent leur valeur réelle que par leur groupement, part la signification qui s'attache à eux.' (Déjerine). A too rigid adherence to apparently contradictory findings leads to endless confusion, and to faulty diagnosis. What are the common errors of assessment?

(1) *The discs and fundi*

A knowledge of the wide physiological variance in the appearance of discs and fundi can only be obtained by constant ophthalmoscopic practice. The ophthalmoscope is a more valuable instrument than the stethoscope, yet how many practitioners even possess, still less know how to use, the ophthalmoscope? The pale disc of myopia is confused with optic atrophy and the normal comparative pallor of the temporal halves of the discs is given pathological significance. Papilloedema is frequently noted where none exists, owing to misinterpretation of two common appearances. Firstly, a greyish disc with indistinct margins, especially on the nasal side, occurs as a normal variant. And secondly, the red, blurred disc of hypermetropia gives rise to error. Ophthalmologists maintain that papilloedema should not be diagnosed if the swelling of the disc is less than $3\frac{1}{2}$ dioptres and this is a good working rule.

(2) *Nystagmus*

Congenital nystagmus is of little neurological significance but its occurrence should be remembered. Gross in amplitude, it is spontaneous in origin, has a rotatory component and is present on movement of the eyes in all directions. In the acquired variety the following criteria are useful:

- (i) Be hesitant in attaching importance to an unsustained oscillation—in noting the findings qualify by the words 'ill sustained' or 'nystagmoid.'
- (ii) When testing, do not put the globes in a position of strain; extreme lateral fixation commonly produces a few jerky movements, in the attempt to fix the test object.

(3) *The tendon reflexes*

Rarely the tendon reflexes are completely absent; a more common finding is absence of one or more of the upper limb tendon reflexes. For practical purposes it may be stated that absence of knee or ankle jerks is always of significance. Reinforcement should always be employed and the technique of examination should be correct. Faulty methods accounts for faulty findings.

(4) *The abdominal reflexes*

A significance often altogether out of perspective is given to the presence or absence of the abdominal reflexes. The extreme variability of the response often leads to confusion but, as a rule, it may be taken that:

- (i) Absent abdominal reflexes may or may not be of pathological significance.
- (ii) A difference in the responses on the two sides is always abnormal.
- (iii) The state of the abdominal reflexes should be assessed in relation to the condition of the whole nervous system.

(5) *The plantar response*

The plantar response frequently gives considerable difficulty in interpretation. An extensor plantar response is such an unequivocal sign of nervous disorders that there should be as little uncertainty as possible as to the mode of response. The following points are of value:

- (i) The optimal site of stimulation is the outer aspect of the sole.
- (ii) The stimulus must be a noxious stimulus.
- (iii) The 'extensor' response is physiologically a withdrawal reflex—producing flexion at ankle, knee and hip.
- (iv) When, therefore, the movement of the hallux gives rise to some doubt, observation of other physiological flexors is helpful. If the hamstrings contract first, then the response is 'extensor'; if the quadriceps first, then the movement is on a more voluntary level.

(6) *Sensation*

Many errors of commission are made during sensory testing. Owing to the subjective nature of sensory testing, no aspect of the examination of the nervous system demands more careful assessment. The following points may be helpful :

- (i) Puzzling and contradictory sensory findings are usually the product of the examiner.
- (ii) Use the drag pin technique in testing for sensory levels.
- (iii) The sensory system tires easily ; too lengthy an examination may produce confusing responses.
- (iv) The most profound sensory change in both cortical and peripheral lesions is usually found at the extremities of the limbs.

IV. Laboratory methods

The intelligent integration of clinical and laboratory findings may lead to conclusions otherwise impossible to reach. Hence, the spinal fluid should be examined in every case of nervous disease. In certain general diseases, notably syphilis, the state of the fluid may also be an important indication for treatment. In general, most information can be gained from four investigations :

- (i) the cell count,
- (ii) the protein percentage,
- (iii) the Lange reaction and
- (iv) the Wassermann reaction.

(1) *Cytology*

Whilst mixed and atypical cell pictures are found, in general, there are three main types of cellular reaction :

- (a) A mononuclear pleocytosis.
- (b) A polymorphonuclear pleocytosis.
- (c) A mixed pleocytosis.

All these differ in their significance but, in general, all reactions imply an infection of the neuraxis.

(a) *Mononuclear pleocytosis.* The cell count is usually below 250—figures higher than this are almost diagnostic of lymphocytic chorio-

meningitis. The common conditions responsible for an increase in monocytes are disseminated sclerosis, neurosyphilis, tuberculous meningitis, cerebral tumour, poliomyelitis and herpes zoster.

(b) *Polymorphonuclear pleocytosis.* Cell counts below 50 are uncommon—with severe polymorphonuclear increase there is always a mononuclear cell increase, usually in the neighbourhood of 10 per cent. of the total. Meningeal infections of all types give rise to the highest counts. A 'leaking' cerebral abscess may also produce an excess of polymorphs in the C.S.F.

(c) *Mixed pleocytosis.* A slight increase of cells (5-10) of both types occurs with a cerebral abscess or in thrombophlebitis of the cerebral venous system. A severe 'mixed' reaction (50-250 cells) is found in acute syphilitic infections of the nervous system, in poliomyelitis, tuberculous meningitis and in cerebral abscess.

(2) *Protein*

An increase in the cerebrospinal fluid protein may be either a solitary finding, or associated with a cellular increase. As an isolated finding it occurs with cerebral neoplasm, subdural haematoma, spinal compression or spinal root neoplasm and in polyneuritis, particularly the acute infective variety. A haemangioma, meningioma or neurofibroma are the neoplasms most commonly associated with an increased C.S.F. protein.

The commonest abnormality of the C.S.F. is an increase of both protein and cells, which usually indicates an infection of the brain and meninges. It may, however, be found in diseases which primarily attack the neuraxis, such as cerebral neoplasm or abscess.

(3) *The Lange reaction*

When normal C.S.F. is added to a colloidal gold solution precipitation of metallic gold does not occur. Certain pathological fluids, however, will precipitate the gold from its colloidal state and this is the basis of the Lange reaction. The chief use is in the diagnosis of neurosyphilis but, in disseminated sclerosis, a paretic curve, with a negative Wassermann, occurs in 10-20 per cent. of patients.

The chlorides. Routine investigation of the chloride content of the C.S.F. is unnecessary. The C.S.F. chlorides follow closely the serum chloride and the fall in chlorides which occurs in tuberculous meningitis to which so much significance is attached, is only symptomatic of a general depletion of the body chlorides.

Radiography

The radiography of the skull and vertebral column demands a high degree of technical excellence. All too commonly interpretation of poor quality plates is attempted with sorry results. The first principle in diagnosis then, is radiographic technique. A.P. lateral and stereoscopic skull views should be taken. The next need is for method—how to look at the radiogram. The cranial bones should be studied first, with attention to :

- (1) The size of the cranial cavity.
- (2) The thickness and density of the bones.

- (3) The suture lines.
- (4) The venous channels.
- (5) The paranasal sinuses.
- (6) The sella turcica.

Having noted any abnormality, the presence of shadows within the cranial cavity should be noted. Calcification may normally be observed in the falx, the pineal body and the choroid plexuses.

Similar principles apply to the examination of the vertebral column. Here, attention should be directed to :

- (1) The alignment of the vertebrae.
- (2) The shape and size of the vertebral body.
- (3) The density of the vertebral body.
- (4) The width of the intravertebral disc.
- (5) The appearance of the laminae.

Accessory radiological examination such as air encephalography, angiography and myelography must be undertaken in specialist clinics.

THE RELATIONSHIP OF THE MEDICAL STUDENT TO THE UNIVERSITY

A Suggestion for Widening the Medical Students' Horizon

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The medical student has become the object of much attention with regard to the form and length of his training (Lewis, 1944) and his selection. In this latter field the problem, rendered acute by the great increase in aspirants to the medical profession, has been discussed by Smyth (1946) as it presents itself to the committee whose job it is to pick out those most likely to become satisfactory doctors. He records the results of investigations into methods of selection recently under trial at University College, London, which have been analysed statistically by Wilkie (1946).

The relationship of the medical student to the University as a whole is a problem that might well be looked into at a time when our

thoughts are directed towards planning the most efficient scheme for the education of medical men of the future.

The place of the student of medicine in the academic world tends to be isolated on account of the more arduous nature of the studies required of him in comparison with those in other spheres of University undergraduate education. Again, in many instances, he is segregated immediately on leaving school into institutions providing preclinical instruction specially remote from the traditional atmosphere of the University. Intercourse with young people of other faculties, *viz.*, science, arts, laws, engineering and theology, does not exist. The usual University activities in the nature of athletic clubs and other less strenuous