Venous Stasis.(1) By THEO. B. HYSLOP, M.D., F.R.S.Edin.

IN order to understand venous stasis in its several relationships to the functions of the brain, it is advisable to refer to some of the problems which have been the most difficult with which neurologists and psychiatrists have had to deal. The aspects of the problems studied have been so varied, and the interpretations of the phenomena so widely different, that it has hitherto been almost impossible to obtain any degree of unanimity of opinion. In dealing with the ætiology and pathology of disease one of the first considerations ought to be to determine, if possible, the existence of physical or mechanical factors of causation.

Functional integrity of the various systems of the body depends upon the maintenance of balance between stimulation, chemical change, metabolism, nutrition, and excretion. For present purposes, however, I propose to exclude from consideration all problems of chemistry and metabolism, and to confine my attention merely to those of the mechanism of "supply and demand" occurring within the skull.

It would appear to be almost useless to attempt to unravel some of the complex problems of intracranial physiology, neurology, and psychiatry, until we have first come to a more definite agreement concerning the nature of the actual mechanism involved.

(1) Is the brain a generator, or merely a transmitter of energy?

The living organism, as in the case with matter generally, can neither create nor destroy energy. The nervous system can only serve as a transmitter or transformer of energy. The attribute, "sensibility," is a superposed phenomenon, and although its physical manifestations may be expressed in terms of energy, it cannot act as a substitute for the energetic phenomena of matter. The excitability and sensibility of living matter provides us with the first elements or rudiments for adaptive reaction for the preservation of life in the substance stimulated. The stimuli are derived from the external world, and the reaction of the organism to them is obtained by physico-chemical activities, which become more highly elaborated as the organism becomes more highly evolved in complexity.

It is probably true that the nerve cell does not initiate energy, but serves as a mechanism for the support, protection, and nutrition of its fibrillar elements, which are concerned with the propagation and direction of energies developed elsewhere. In fact, the *rôle* of the nervous fibrillæ is to transmit an impulse from one point to another. Morat (*Physiology of the Nervous System*, p. 48) has stated this very clearly: "The body of the cell of the neuron is an organ necessary

(1) A paper read at the Spring Meeting of the South-Eastern Division, May 5th, 1920.

for the organisation and conservation of the latter, but it takes no necessary and direct part in its power of functional activity so-called."

From these remarks it will be gathered that the statical and dynamic unit of nerve is to be sought in the nervous or fibrillar substance proper, and any observations derived from experiment on the nerve cell or medullated fibre must be imperfect so long as they do not exclude the organotrophic energies. The true static unit of nerve must, in common with other units, possess chemical, caloric, and electric force which undergoes transformations when the specific energies of the nerve units are called into play; but of the nature and source of these energies and excitations of their transmitted and localised effects, and of the possibility of their being held in reserve, nothing is definitely known. As a matter of fact, the experiments of Rolleston, Stewart, and Boeck (who endeavoured to estimate by means of an apparatus sensitive up to 1–5,oooth of a degree the amount of heat given off by an isolated nerve trunk) gave no results. Similarly, many physiologists agree with Hermann that electric nerve currents do not pre-exist, any currents which do occur having a chemical source and arising under entirely artificial conditions. The various modifications of the body of the cell during repose and functional activity and the phenomena of chromatolysis pertain to the trophon and not to the static units of the nerve proper, which are relatively almost incapable of fatigue.

(2) Is the sum total of the intracranial contents capable of variation in amount?

In a paper read before the Hunterian Society (Hunterian Lecture on "Intracranial Murmurs in their Relationship to Tinnitus Aurium," *Lancet*, October 14th, 1911), I there stated that the term "cerebral pressure" really means either undue preponderance of one or other of the cranial contents, *partial displacement* of one or other constituent, acceleration of the arterial or retarding of the venous circulation, or alteration in the compensatory movements of the cerebro-spinal fluid. Arterial, venous, lymphatic, and other forms of pressure due to injury or disease, etc., are but terms used to signify alterations either in the position or in the relative quantities of the cranial contents. The intracranial contents being in the sum incapable of expansion or contraction, it is of importance to note the mechanism whereby the "give and take" between them is affected. The brain itself is passive, and depends upon arterial, venous, respiratory, and peristaltic movements for its metabolism and activities. Its substance may be displaced, contracted, expanded, or destroyed by injury, disease, new growths, or finer interstitial degenerative changes. The arterial system may preponderate unduly in its activities, the relative amount of arterial blood being greater than in health. This is due either to excess of propelling action in the arterial system or defect in resistance of the

venous or lymphatic systems. The arterial blood may be diminished, on the other hand, owing to defect in the propelling mechanism or to increase in the resistance offered by the venous or lymphatic systems. Similarly, the arterial and venous systems may be concurrently hyperactive or deficient owing to diminution or excess of the lymph cisterns. Perfect balance of the relative quantities of the cranial contents thus presupposes certain activities or movements, which are also essential to proper metabolism. The skull thus regulates the pressure of the fluid within its cavity, and any functional increase in the arterial blood would be possible only upon one of two conditions, *viz.*, a corresponding collateral arterial diminution, or a transfer of venous blood in the direction of the venous sinuses. A venous transfer would be altogether too slow, and there could not be any continuous action, for the repulsion of the venous current—dependent upon the respiratory movements—would give rise to a frequently interrupted flow of venous blood in the brain. The cranial cavity is not, however, entirely filled by the brain; it includes, in addition, a number of spaces filled with lymphatic fluid.

The Monroe-Kellie doctrine, that the intracranial contents are, in the sum, a fixed quantity, has not yet been fully conceded. If, however, we can start with the acceptance of this doctrine, a vast field of possible explanations of intracranial phenomena becomes open to us.

Alexander Monro (Secundus) wrote as follows (*Observations on the Structure and Functions of the Nervous System*, p. 5): "As the substance of the brain, like that of other solids of our body, is nearly incompressible, the quantity of blood within the head must be the same, or very nearly the same, at all times, whether in health or disease, in life or after death, those cases only excepted in which water or other matter is effused or secreted from the blood-vessels, for in these a quantity of blood equal in bulk to the effused blood will be pressed out of the cranium."

Many other observers have, from experiments and reasonings founded on the mechanical construction of the cranium, concluded that the absolute quantity of blood within it is at all times nearly the same, and were the other intracranial contents, such as the extravascular serum, the connective and nervous tissues, fixed quantities also, the quantity of blood would be absolute and invariable. Thus it might be conceded that any variation in the relative quantities of the fluid constituents must consist in a "give and take" between extravascular and intravascular contents, one acting as compensatory to the other.

Were we to attempt to drain the cranium of its fluid contents by aspiration of its veins at their points of egress, we would find that we could not really diminish the sum-total, for there would always be

compensatory filling of the cranium by fluid unless, of course, the mechanical forces were sufficient to create a vacuum.

The next principle to recognise and acknowledge is that, in accordance with the law of pressure of fluids, the tension throughout the nerve structures which are supported and everywhere permeated by fluid must be equivalent, or nearly so, at every point. The disposition of the solid tissues is, of course, determined by the volume, strength and direction of the blood currents. The mechanism whereby one set of vessels feeds and another drains the capillaries, and whereby the balance between lymph supply and metabolic change in the nerve structures is maintained, will be more fully comprehended if we bear in mind this fundamental principle. When we speak of local congestion, or local pressure, as occurring within the skull, we mean, therefore, that there is a relative preponderance of one or more of the constituents, with compensatory diminution of one or more of the other constituents, this diminution being affected by displacement which, when viewed in its external manifestations as an extension through one or more of the cranial apertures (along lines of least resistance), becomes, strictly speaking, extracranial, and causes conditions which bear a certain homology and analogy to conditions of hernia. Thus it is that all the apertures for the ingress and egress of vessels and nerves, to and from the cranium, become the sites at which the compensatory mechanism of give and take must necessarily find the greatest strain, and it will readily be understood how under disturbed conditions of balance between the relative proportions of the intracranial contents the various sensory and other structures attached to the cranium may become mechanically and also pathologically affected.

Of late years Leonard Hill, Baylis, Elder, Bradbury, Geigel, Hurthle, Roy and Sherrington, Cavazzini, Pusateri, Acquisto, d'Abundo, Mosso, Duke, De Sarlo and Bernardini, Ford Robertson, and many others, have contributed very valuable observations to the discussion. Any divergencies of opinion which may have arisen have been (1) from imperfect comprehension of the real nature and mechanism of the contents of the cranium; (2) from faulty interpretation of the anatomy and physiology of these contents; and (3) from experiments conducted upon structures and mechanisms which are really extracranial.

It is essential to recognise that the brain is mainly of fluid consistence, *i.e.*, of arterial, capillary, and venous blood, and also of lymph which occupies not only the ventricles and cisterns, etc., but which also circulates in the perivascular canals and permeates everywhere, even within the nerve-cells, and possibly even to the nuclei and nucleoli. Under these circumstances it is evident that we are dealing with what is, to all practical purposes, a fluid medium which must conform to the ordinary laws of hydrostatics. Hence the incompressi-

bility of the brain, replete as it is with fluid, is imaginary and not real. It seems obvious, therefore, that the term "pressure," as applied hitherto to the intracranial mechanism, requires modification.

The cranial cavity may be compared to that of a hose syringe, the perforations at its nozzle corresponding to the usual points of egress for the fluids (*i.e.*, the normal channels into the veins, lymphatics, and the spinal column). If we close some of the numerous orifices at the base of the skull normal conditions are able to resist the outflow of fluids from the cranium. Any displacement of fluid takes place along the lines of least resistance, and it will pass out of the skull (in physiological conditions of health). If, however, this process of displacement is arrested, the fluid then seeks to escape from the points of lesser resistance, and the phenomena of dizziness, ringing in the ears, flashes of light, rhinorrhœa, choked discs, etc., are occasioned, the intracranial fluid seeking to escape by unusual channels. In any experiments to determine intercranial pressure it would appear to be fallacious and misleading to deal solely with conditions of pressure outside the skull. This objection is obvious when we reflect that the mechanical, anatomical, physiological, and atmospheric conditions outside the skull are totally different from those within it.

The doctrine of the incompressibility of the brain-tissue being a myth, it seems necessary to find some means by which the brain may best react mechanically to the expanding influences brought to bear upon it. In the absence of any direct influence derived from atmospheric pressure, the arteries, arterioles, and capillaries are provided with a relatively greater amount of elastic tissue than exists in these vessels elsewhere, and it is by means of this elasticity of the vessel walls that resistance to their undue expansion and also their power to contract become possible. Under the general laws of hydrostatics it is inconceivable that increase of local pressure can occur or bear any significance other than as being an increase in volume of one constituent at the expense of the volume of other constituents, any actual conditions of pressure or tension being the same throughout the whole of the intracranial contents. Needless to say, the presence of tumours or other foreign bodies may not only cause alterations or displacements of structure, but also alterations and displacements of the sum-total, or alterations in the relative proportions of the fluid constituents.

Excluding spatial or mechanical encroachments from without (as in depressed fractures), or from within (due to intracranial tumours, foreign bodies, etc.), the sum-total of the intracranial contents is not only constant and invariable, but the pressure throughout the sum-total of the contents is also universal and equivalent.

The intracranial mechanism being thus passively dependent upon extracranial factors, there becomes no need for a special vasomotor

nerve-fibre mechanism such as pertains to vessels of the body, and the long-continued dispute as to the presence or absence of special vaso-constrictor and vasodilator fibres within the cranium can probably be finally settled if this assumption be true.

It would seem that the various intracranial movements due to pulsatory and respiratory factors are entirely extracranial in origin and force; and it will probably be conceded that any evidences of intracranial vascular peristalsis are merely evidences of propagation of the peristalsis common to the arterial system right up to the points of ingress of the arteries to the skull, *i.e.*, the intracranial waves owe their peristaltic variations more to the variations in volume of the arterial waves propagated from without than to any actual vasomotor influence acting on the vessels within the skull itself.

In speaking thus of intracranial local tension it must, of course, be conceded that there may be, under pathological conditions, a struggle for supremacy between different contents. It is also to be noted that no account is here taken of osmotic or other influences which serve to preserve the balance between fluids of varying consistency.

The usefulness of applying mechanical and mathematical principles for the explanation of intracranial disease is evidenced in a remarkable degree when we study the disturbances from which the brain and its adnexa are prone to suffer. Thus arterial inflammatory affections, capillary engorgements, and increase of serous exudation and diapedesis of leucocytes, with ultimate formation of connective tissues, can be represented by more or less definite formulæ. Similarly alterations in the relative proportions of the lymph as a whole, or in its relationship to individual units such as the neurons, can be defined in mathematical terms; and lastly the processes of excretion by the lymphatics, the venules, veins, and sinuses may be considered either separately or in their entirety. Intracranial physics has not yet elaborated the mechanism of backward pressure in the vascular structures, and seldom do we find anything in treatises on diseases of the brain which tends to throw much light upon the mechanism or results of backward venous pressure. We know that venous congestion and stasis do occur, and that the surface veins of the brain are in almost immediate juxta-position to various brain centres, but the variations in venous pressure and their effects on the cortex as occurring in health and disease have as yet been scarcely touched upon. We have here, therefore, an almost unexplored field for research.

It should be recognised that the cranium and its contents are dependent upon the blood for nutrition and repair, and that the processes of nutrition and repair are dependent not only upon an adequate mechanism of arterial supply, but also upon an adequate mechanism of venous drainage. The cranium and the pelvis hold

a somewhat similar relationship to the general circulation, and their contents are dependent respectively on similar conditions of arterial supply and venous drainage. This being the case, and recognising the close similarity between the two departments, it becomes evident how, under certain mechanical defects in the circulation, a double series of phenomena becomes manifest. It is an old observation that congestion of the pelvic contents is apt to be simulated in the brain, as evidenced by the nervous and mental symptoms associated with constipation. The comparison could be carried still further so as to include, on the one hand, the numerous troubles arising from congestion of the various pelvic viscera, and, on the other hand, the almost innumerable varieties of symptoms arising from delay of the venous return, not only from the various orifices of the skull, but also from the cerebral convolutions themselves. Such conditions as hæmorrhoids, which are extrapelvic in site, are simulated by the various conditions of extracranial congestion occurring at the orifices of egress of the cerebral and cranial veins, either singly or in relationship to the cranial nerves and the special organs of sense. It will readily occur to all present how, under conditions of lowered blood-pressure, a tendency to venous stasis might readily occur, and, viewed from the purely mechanical standpoint, the indications for treatment are evident. In his Croonian Lectures on the "Degeneration of the Neuron" (1900), Mott made some extremely valuable obervations in regard to the part played by venous congestion in the production of various forms of nervous and mental disease. He there pointed out the means whereby a vicious circle becomes established by conditions which tend, on the one hand, to perpetual venous congestion in certain regions, and, on the other, to increased excitability of the neurons, these factors mutually interacting. It seemed to be a remarkable fact, that whereas much attention has been paid to the question of the arterial supply to the brain, the venous drainage from the various convolutions has been somewhat neglected. This is all the more remarkable in view of the close relationship between the veins and their surface of drainage from the various convolutions. When one considers the question of the vital importance of an effective drainage from the various sensory and motor regions, it becomes difficult to avoid recognising that many of the groups of symptoms met with in neurasthenia are not only of localising value, but also form indications as to the treatment necessary. I think, however, that this is not the occasion to elaborate the observations of Mott with regard to the part played by venous congestion regarded from a regional point of view, but I believe the time is not very far distant when many of the types of neurasthenia will come to be regarded as being due to local conditions of a mechanical nature, and dependent upon factors which are entirely

extracranial in origin. The tendency to perpetual venous congestion in certain regions, referred to by Mott, is markedly exemplified in some parts of the course of the superior longitudinal sinus and in the area drained by the great anastomotic vein of Trolard. Just as the left middle cerebral artery is the artery of greatest wear and tear, so certain veins are subjected to greater exercise of function than others, and it is to the efficient drainage from these veins that more attention might with benefit be given. Speaking generally, I might state, with some degree of truth, that oftentimes what has come to be regarded as a familial neurotic taint is merely a familial defect in the bodily mechanism, whereby individual members of the family, whilst possessing finely evolved brains, are prone to neurasthenia because their brains are but imperfectly served by the bodily mechanism. The practical indications for the treatment of such cases are very clearly defined, and I have found benefit to accrue from complete rest of the areas which are drained defectively. One general principle of treatment is to increase the force of the arterial wave by cardiac stimulation, and to favour the venous return by aiding the inspiratory venous suction by forced inspiration, plus passive pressure, or massage, extending from the occiput downwards. Abdominal massage is also of considerable value, and more especially so when it serves to stimulate intestinal peristalsis. With regard to the special senses, I would give only one example of the effects of treatment by complete rest. The temporo-sphenoidal convolutions are particularly prone to suffer from venous stasis, and in order to give them complete and absolute rest, and more especially when auditory disturbances are present, I recommend for that purpose plugging of the meatuses by suitably devised plugs of paraffin wax. By this method I have afforded relief from hallucinations of long standing.

In presenting to you these views on cerebral congestion and its results, I venture to hope that I have not only afforded material for discussion, but that I have also helped to throw some light on certain aspects of cases which are not only remarkably frequent in their occurrence, but which are also most difficult of explanation. It must not be assumed that my remarks apply to all cases of cerebral congestion, for there is of course another series of morbid phenomena due to high tension with arterial capillary fibrosis and the usual series of pathological changes ranging from sclerosis to actual hæmorrhage and paralysis.

Résumé.

ACTIVE CONGESTION is due to:

(1) Over-action of the heart and whatever increases the force of the heart.

(2) Sudden contraction of the arterioles elsewhere—as, for instance, in the skin from exposure to cold or during a rigor—causing transient over-filling of the cerebral vessels together with those of other viscera.

(3) Dilatation of the arterioles, and consequently an increase of the blood-supply, produced by certain toxic agents, especially by nitrite of amyl, nitro-glycerine and alcohol. In exophthalmic goitre vascular dilatation is associated with cardiac over-action. In some young neurotic persons periodic congestive disturbances are frequent.

(4) Active congestion occurs as the first stage of inflammation. Convulsions may be due to active or passive congestion.

(5) Sunstroke is said to be not infrequently attended by active congestion, but in my opinion the congestion is generally passive and due to extracranial and hygrometric causes.

(6) In acute febrile diseases the delirium is usually due primarily to toxins and secondarily to congestion.

(7) Plethora in adults with an increase in the total quantity of blood in the system, when attended by the suppression of an habitual discharge, especially hæmorrhagic, as from piles or catamenia, or rhinorrhœa, epistaxis, etc., is apt to be attended by congestion, and in this relationship many chapters could be written.

(8) In many instances the active condition of congestion may be local, as in connection with tumours, focal lesions, etc., but with these there is no need to deal.

PASSIVE CONGESTION is always produced mechanically by some obstruction to the return of blood. It occurs in heart disease when there is over-filling of the venous system; in conditions of pressure on the superior vena cava, or on the innominate veins, or on the veins of the neck in tumours, etc.; in obstruction to the flow of blood through the lungs in coughing, playing wind instruments; in strangulation from tight collars, in suffocation, and in spasmodic muscular conditions affecting the throat, as in epilepsy, etc.; in causes due to gravitation and the various types of asphyxiation, but most commonly of all to deficient arterial pressure.

Of the various symptoms of the plethoric and adynamic types there is no time to devote to their further elaboration. Gowers, after having fully elaborated the pathology and symptomatology of the various cephalic sensations, states that there is not the slightest justification for attributing them to congestion of the brain, and he states contemptuously that when such patients consult many doctors, as they usually do, they are told that their symptoms are due to congestion of the brain, or even (with a precision that is evidence only of profound

ignorance or of actual charlatanry) to "congestion of the base of the brain"—a condition that probably never exists but in a pathological imagination. Needless to say this sweeping assertion is consistent neither with his own findings nor with those of any other observers who have studied the conditions to which he refers.

I have referred frequently to the value of massage of the base of the skull, the neck and spine, to ensure free movement in the veins and lymphatics. This should be conducted rhythmically from above downwards to synchronise with expiration and the draining of venous fluid from the skull. It is sometimes remarkable how this relieves stasis in the basal veins, the petrosal and cavernous sinuses, and not infrequently an anæsthesia, more or less general, improves rapidly with draining of the straight sinus, thereby relieving the intra-commissural areas concerned with cutaneous sensation.

I have also found that rhythmic exercises relieve conditions of venous stasis which hitherto have not yielded to any other form of treatment. In many cases I believe it to be essential to aid the circulation by careful estimation of the internal secretions and adjustment of the balance between the thyroid, pituitary, adrenal, ovarian, and testicular functions.

The Functions of the Basal Ganglia.[1] By J. V. BLACHFORD, *C.B.E.*, M.D.Durh., Medical Superintendent, City Mental Hospital, Fishponds, Bristol, and Lecturer on Mental Diseases, University of Bristol.

IN the *Journal of Mental Science*, vol. xlviii, 1902, p. 53, I described a case of degeneration of the optic thalami in a male patient, and pointed to the fact that the symptoms were chiefly those of very advanced dementia.

Some years later a female patient, who had been resident in the asylum for a number of years, died. The following is a short history of her case and the conditions found *post-mortem*:

E. T—, a female patient, æt. 78, had two or three attacks of partial aphasia; the last and worst occurred some months before her death. There was no paralysis, but patient complained of feeling giddy and at the same time was at a loss to remember certain words in conversation. From the first attacks she recovered completely; as regards the last, her aphasia had much improved but she was evidently becoming more childish, and her death was certified as due to old age. *Post mortem:* The vessels at the base of the brain were noted as very atheromatous, the grey matter pale and firm, the white matter pale and firm, and ependyma of ventricles smooth. There was a fairly large patch of softening in the right corpus striatum and a smaller one in the left. In this case the only lesion to account for the aphasia was softening in the corpora striata.

I have searched the *post-mortem* records of this asylum for the past twenty years, and in all cases in which the lesion could be localised in

[1] A paper read at the Autumn Meeting of the South-Western Division on October 28th, 1921.

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