

a period of uncertain duration, which has been not inaptly named the *mixed stage*, in which the "symptoms of irritation still linger and the symptoms of depression are just manifesting themselves" (Bartholow).

Paroxysms of pain, great restlessness, irritability, and delirium are succeeded by periods of extreme drowsiness or even of profound stupor, out of which the child is aroused with difficulty, perhaps replies in monosyllables, or stares vacantly at the questioner through half-open lids, and again lapses into his former condition.

The most characteristic feature of this stage when fully developed is loss of consciousness. The patient remains in a state of complete insensibility, and at times moans or shrieks out wildly. He commonly lies on one side, with the knees drawn close to the abdomen, one hand pressing his head and the other grasping the genitals.

The head is often retracted, and the muscles of the nape of the neck are rigid. The pulse becomes slow—from 40 to 80 beats in the minute. The irregularity of the pulse and respiration are more pronounced and more constant than before. Typical Cheyne-Stokes respiration is often observed. The temperature falls a degree or more and often becomes subnormal. Vomiting ceases, if it has not already done so, but constipation persists. The abdomen is deeply hollowed. The common term "boat-shaped" very accurately describes the sunken belly bounded by the unduly prominent symphysis, iliac crests, and ensiform cartilage.

The pupils are dilated, often unequally, and sometimes waver under light. The globe rolls from side to side, the sclerotic is suffused, a puriform secretion collects in the angles of the eyes or glues together the edges of the lids. The ophthalmoscope shows ischæmia of the optic discs or beginning neuro-retinitis. In rare instances, miliary tubercles are seen in the choroid. Dr. Allbutt found retinal lesions in twenty-nine out of thirty-eight cases of tuberculous meningitis.

The skin presents peculiar vaso-motor disturbances. Small patches or spots of congestion appear on the cheeks, forehead, or ears, and quickly fade away, their bright color making a vivid contrast with the general pallor. If the finger-nail be lightly drawn across the abdomen or inner surface of the thigh, a bright-red line comes out slowly, persists for a few moments, and then gradually fades—the *tâche cérébrale* of Trousseau.

Paralyses, both local and general, are commonly met with at this period; as are also rigidity or pendulum-like movements of one or more of the extremities.

The contents of the bladder and rectum are usually discharged involuntarily.

Stage of Paralysis.—From twenty-four to forty-eight hours before death, some of the characteristic symptoms undergo a remarkable alteration. The period covered by these changes is known as the stage of paralysis. The child now lies completely comatose and irresponsive to external irritations. Only reflex movements can be excited, and these imperfectly.

The constipation which has marked the whole progress of the illness is now often replaced by copious, involuntary, liquid stools; the sunken abdomen becomes distended with gas; the slow pulse becomes rapid and feeble, numbering 160 to 180 beats per minute, and the mercury registers a temperature of 104° to 107° F. This second rise in pulse and temperature is a certain forerunner of speedy dissolution.

The capillary circulation is more and more interfered with, the respirations become less distinct, and death may occur quietly in deep coma or be ushered in by a convulsion. Death by coma is the more common mode.

Sometimes the death agony is prolonged for several days, to the great grief of the parents. Death occurs in from sixteen to twenty-one days after the appearance of the initial symptoms.

TUBERCULOUS MENINGITIS IN THE ADULT.—The course of tuberculous meningitis in adults varies sufficiently from that observed in children to deserve brief mention.

The disease is more common in men than in women,

and occurs at all ages, but especially between the years of seventeen and thirty. It is almost invariably secondary to advanced tuberculous disease in some remote part, the symptoms of which to a certain extent mask those of the meningeal affection. The primary form of the disease is rarely met with in adult life.

Premonitory symptoms are usually absent, and when present never obtain the same prominence as in early life. Persistent vomiting and convulsions rarely usher in the attack, but local paralyses, hemiplegia, and aphasia—very seldom seen in childhood—are not infrequently the first symptoms to direct attention to the cerebral complication.

The disease ordinarily runs a much shorter course than in children. Death may occur within forty-eight hours after the appearance of brain symptoms, and is seldom delayed longer than fourteen days.

DIAGNOSIS.—The diagnosis of typical, fully developed tuberculous meningitis can scarcely give serious trouble, but in the prodromal period, or in those cases which pursue an irregular course or in which some of the prominent symptoms are absent altogether, it is proverbially difficult.

Since the disease is almost invariably engrafted upon a tuberculous diathesis, a careful investigation of the family record and personal history should be at once instituted. It is, however, only by the exercise of the most painstaking care, by closely observing the physiognomy and actions of the child, and by noting the hourly variations in the symptoms, that an early diagnosis can be reached in doubtful cases. Ill-defined ailing in a scrofulous child which resists ordinary treatment, especially if accompanied with headache and causeless vomiting, should always awaken suspicion.

The diseases for which tuberculous meningitis is most liable to be mistaken are acute simple meningitis, hydrocephaloid disease, gastro-intestinal disturbances, and typhoid fever.

Simple meningitis is ordinarily recognized by the sharper onset (without prodromes), more severe headache, more furious delirium, higher temperature—in short, the greater intensity of all the symptoms and its rapid course. The comparative rarity of the simple over the tuberculous form of the disease should be remembered. In exceptional cases the differentiation cannot be made.

False hydrocephalus is usually readily known by the history of antecedent diarrhoea or other exhausting malady, the prostration when the cerebral symptoms began, the rapid and feeble pulse, the depressed fontanel, the pallor, and the normal or even subnormal temperature. All authors speak of the resemblance which certain cases of typhoid fever bear to the disease under discussion. The infrequency of typhoid fever in patients of the age most prone to tuberculous meningitis, the regular temperature curve, the diarrhoea, the iliac gurgling, the rose-colored spots, and the splenic tumor will generally easily establish the nature of the disease.

The subacute gastro-intestinal disturbances to which children, especially cachectic children, are so liable may lead to error. Feverishness, anorexia, vomiting, irritability, and headache are common to each, and in many cases the development of the symptoms must be awaited to clear up the diagnosis.

The more intense headache, the irregular pulse, the sighing respiration, the alterations in the pupils, and the graver aspect of the illness will generally speedily indicate its cerebral nature.

The lumbar puncture of Quincke sometimes gives valuable information. It is especially valuable in the differentiation of meningitis from other diseases accompanied by marked brain symptoms.

The discovery of tubercle bacilli in the spinal fluid is positive evidence of the nature of the disease. They are, however, difficult of demonstration, and are not always present in undoubted cases of meningeal tuberculosis.

Fürbringer found bacilli in thirty out of thirty-seven examinations.

The changes which take place in the fundus of the eye are often among the early signs of meningeal inflammation, and hence are valuable in diagnosis. However, too much reliance must not be put upon the ophthalmoscopic examination. Dr. Fagge remarks: "The clinical value of ophthalmoscopic changes in the optic discs is still somewhat doubtful. It is certain that a normal state of the retina is no proof of the absence of tuberculous meningitis, but I believe the time has not yet arrived for a dogmatic expression of opinion as to the positive significance of ischæmia (or even of retinitis) as between that disease and some less severe affection of the brain, such as might be attended with great vascular congestion of its tissue. One appearance indeed is conclusive, namely, the presence of tubercles in the choroid. It is true that they belong not to the meningeal affection itself, but rather to a general acute tuberculosis, but this fact in no degree diminishes their diagnostic importance" ("Practice of Medicine"). Dr. Minot says on this point that "choroidal tubercles are so rarely seen as to be of little avail in diagnosis. In fact, they are less frequent in this disease than in general tuberculosis without meningitis. In twenty-six cases of tuberculous meningitis examined by Garlick at the London Hospital for Sick Children they were found only once" (Pepper's "System of Medicine").

Dr. Bastian (Quain's "Dictionary of Medicine") places great reliance upon the microscopic examination of the blood in the diagnosis of tuberculous meningitis. He mentions the following alterations in the blood as peculiar to this affection: an increase in the number and exalted amoeboid activity of the white corpuscles; groups of protoplasmic particles of various sizes interspersed among the blood corpuscles, as well as here and there small pigment granules. The red corpuscles tend to run together into irregular masses rather than into definite rouleaux, but present no distinctive changes.

PROGNOSIS.—The prognosis is absolutely bad. When fully developed, tuberculous meningitis almost invariably marches steadily on to a fatal termination. Delusive lulls not infrequently occur, however, even in the advanced stages, when an unwary practitioner may doubt his diagnosis and raise hopes in the parents which are doomed to bitter disappointment.

The possibility of recovery from the early stages of the disease cannot now be successfully denied, although it is not, perhaps, uncharitable to doubt the correctness of the diagnosis in many of the recorded recoveries. Rilliet, Rousseau, and other equally eminent clinicians report cases in which death occurred from a relapse some time after recovery from the first attack; and at the autopsy, old and recent tubercles of the pia could be clearly distinguished. Huguenin does not even accept the revelations of the post-mortem examination as conclusive, and remarks that "pathological anatomy furnishes no information the correctness of which it would not be possible to doubt."

The isolated exceptions who do survive an attack of tuberculous meningitis are nearly always left with impaired mental or physical powers, and sooner or later succumb to a recurrence of the disease.

The writer has seen recovery in one case which was well advanced in the second stage, and in which there could scarcely be a doubt as to the tuberculous nature of the disease; but the patient never fully regained his mental faculties, and died in convulsions eighteen months afterward.

TREATMENT.—Tuberculous meningitis is so universally fatal that but little benefit can be hoped for from the administration of remedies. There are no drugs that can control or retard the specific action of the tubercle bacilli on the membranes of the brain. The treatment is wholly symptomatic and palliative. Treatment should not, however, be abandoned too soon, as a positive diagnosis between the simple and the tuberculous form of meningitis is not always possible in the early stages.

In the present stage of our knowledge, the greatest good must come from the adoption of measures to pre-

vent the development of the cachexia in those so predisposed. It is not necessary for us to detail here the special means to be employed; they are set forth at length in other chapters of this HANDBOOK.

In general terms, however, we may say that, in the presence of the diathesis every influence which tends to develop the nervous system at the expense of the digestive and muscular systems will increase the liability to the disease.

The violent antiphlogistic measures formerly employed in the treatment are now properly discarded. As soon as the nature of the disease is known or strongly suspected, the patient should be placed in a darkened room and all sources of cerebral excitement excluded. An active calomel purge should be at once administered. An ice-cap must be applied to the head and upper portion of the spine and warm applications to the extremities.

Special symptoms must be met as they arise by the use of the customary remedies, but our chief reliance in arresting the disease lies in the use of the bromide and iodide of potash. The bromide may be omitted during the pressure stage, unless convulsions ensue, but the iodide must be given until treatment is abandoned.

Sometimes, during the stage of excitement, opium may be advantageously combined with the bromide. Flattering reports have been published from the use of iodoform inunctions, and a Swedish physician, Dr. Warfvinge, reports five successful cases. The method followed by Dr. Warfvinge consists in shaving the head and anointing it with an ointment consisting of iodoform, 1 gm., in vaseline, 5 gm. This is applied twice daily, the head being afterward covered with an impermeable cap. This method has still a few advocates, but it never gained the confidence of the profession and is practically abandoned. Lumbar puncture has been recently practised in a large number of cases, both as a curative and as a diagnostic measure, but the later reports are not such as to commend the practice. Rotch and Wentworth report alarming symptoms following its use in a two-year-old child.

W. J. Conklin.

BRAIN, TUMORS OF THE.—The symptoms caused by tumors of the brain are due, first, to irritation or destruction of the portions of the nerve tissue in which they are embedded, or near to which they lie; second, to pressure exercised upon the entire contents of the cranium—nerve tissue, blood-vessels, and lymphatics. The first class of symptoms are common to tumor, and to all other circumscribed lesions of the same locality, thus especially patches of chronic softening. The second class are common to all conditions in which the intracranial space is encroached upon; such are extra- as well as intra-cerebral tumors, morbid products within the brain, which differ considerably from neoplasms proper, and finally, abscesses and aneurisms. Thus, the investigation of the case of any patient exhibiting cerebral symptoms demands that we decide: first, whether these are caused by a new growth of any kind, which is encroaching upon the cranial cavity; second, this being admitted, what is the nature of the growth; third, what is its precise locality.

The prognosis must then be framed according to the fact, the nature, and the seat of the growth; and, finally, the (very limited) indications for treatment must be considered.

SYMPTOMS INDICATING THE EXISTENCE OF AN INTRACRANIAL GROWTH.—These are of two kinds: those belonging to the perversion or abolition of cerebral function, and those indicating a rise of intracranial pressure. The first are the focal, the second the diffused symptoms (Griesinger). It is this second class of symptoms which are of the most importance in distinguishing between tumor and other cerebral lesions, and they may therefore be considered first.

Diffused Symptoms.—These are headache, vertigo, vomiting, general epileptiform convulsions, apoplectiform attacks, psychic disturbances, and choked disc.

Headache is one of the earliest and most constant symptoms of intracranial tumor. The intensity of the pain

is usually severe, has even led to suicide, but this very intensity may sometimes confuse the diagnosis with hemiparesis. From this functional disease it is sufficiently distinguished by its persistence. It may, for some time, precede all other symptoms of tumor. Although it is on the whole persistent, there may, in a certain number of cases, be intervals of freedom of several hours, days, weeks, or even months in duration. Not unfrequently is the headache periodic, and it may then be mistaken for an apyretic malarial attack. Frontal headache may simulate brow ache, or occipital headache the cervico-occipital neuralgia of gout. The pain is apt to be exacerbated at night, or to grow worse in the early morning hours, a fact probably due to stagnation of the intracranial lymph stream determined by the lowered blood pressure during sleep. The pain is also increased by every condition liable to cause congestion of the head; thus by psychical excitement, alcohol, straining at stool. The headache may be diffuse or localized, but the localization of the pain does not assist much in the localizing diagnosis of the tumor. Frontal tumors frequently excite occipital headache. Although so prominent a symptom when it exists, headache is by no means always present. It was absent in 148 out of 274 cases analyzed by Ball and Krishaber. By combining the tables of Ladame and of Bernhardt (the first summing up all cases published earlier than 1868, the second those between that date and 1880), we can construct the following table, showing the proportion of cases of headache with cerebral tumors of different localities:

TABLE I.

Seat.	Number of cases.	Number with headache.	Per cent.
Cerebral peduncle	10	4	40
Basal ganglia	41	19	46
Cortex	74	37	50
Medulla	28	16	60
Cerebral lobes	196	129	66
Pons	56	37	67
Corpora quadrigemina	13	9	69
Cerebellum	186	150	81

This table confirms the inferences that might be drawn from what we know of the physiology of cerebral pain. It is rarely to be attributed to irritation of sensory centres, but rather to stretching of the dura mater from effusion into the cavity of the arachnoid or into the internal ventricles; hence irritation of the dural sensory nerve filaments supplied by the trigeminus. As some degree of stretching always takes place, no matter what the seat of the tumor, headache is always imminent, but it may not manifest itself if the tumor grows very slowly and makes way for itself by gradual compression of the

ache with tumors of the corpora quadrigemina may perhaps be due to their intimate connections with the cerebellum. In the cortex, only half the cases are attended by headache; this probably being due to the tendency of the tumor to grow downward, and thus to relieve the tension of the dura. The periodicity in the pain is undoubtedly associated with fluctuations of the circulation, always liable to be diurnally periodic. An initial headache often disappears when paralysis sets in; probably because by that time a zone of softening has usually developed around the tumor. The intensity of the pressure is at first either partially or entirely relieved; headache may set in if the tumor suddenly assume a more rapid rate of growth; it necessarily subsides at the appearance of the terminal symptoms of drowsiness and comatose apathy, the pain being blunted, like other signs of irritation, in the general depression of the sensibility.

Vertigo is a much less frequent but still a prominent symptom of any organic brain disease, and although frequently present with tumor, is far from characteristic of it. It is probably always associated with direct or indirect irritation of those portions of the brain which are concerned in equilibration; and it agrees well with this presumption that vertigo occurs so much more frequently with tumors of the cerebellum than with those of other parts of the brain. It is also frequently observed in tumors of the pons and medulla. Other space-encroaching lesions, e.g., abscesses, so situated as to affect the middle or internal ear, may cause vertigo by the same mechanism as that which is brought into play in ear disease proper—namely, by excitation of the auditory nerve. As the central fibres of this nerve have been traced to the cerebellum, it seems probable that the sensation of vertigo, whether cerebral or aural in origin, is always finally produced by the same mechanism. From the connection of the ocular muscles with the superior olive, and through that with the auditory nerve, paralysis of these muscles by a brain tumor may become an effective cause of vertigo (Bruns).

The third diffused symptom, Vomiting, follows the same order of predominance as headache and vertigo, namely, it is much more frequent and severe in tumors of the cerebellum than in those involving some other portion of the brain, with the exception of the corpora quadrigemina, where the liability to vomiting is at the maximum.

From the following table it appears that vomiting is a much less frequent symptom than headache, and occurs later, but follows exactly the same order of predominance, except in respect to the centrum ovale. This is because the vomiting is partly due to the same cause as the headache, namely, the tension of the dura mater and the tentorium. Extreme tension does not, however, always cause vomiting.

TABLE II.

Seat of tumor.	Headache.		Vomiting.		Convulsion.		Choked disc (Bernhardt alone).					
	Cases.	Per cent.	Cases.	Per cent.	Cases.	Per cent.	—Amaurosis.—		—Vision intact.—		—Total.—	
							Cases.	Per cent.	Cases.	Per cent.	Cases.	Per cent.
Cerebral peduncle	4	40	..	..	2	20	15 in 124	12	12 in 124	9 = 27 in 124	21	21
Cerebral lobes	129	66	36	18.5	49	26	2 in 20	5 = 2 in 20	5 = 2 in 20	7	7	7
Basal ganglia	19	46	8	19.5	7	19	5 in 57	8	5 in 57	9 = 10 in 57	17	17
Cortex	37	50	18	23	20	25	4 in 30	13	2 in 30	6 = 6 in 30	20	20
Pons	37	67	15	27	2	5	2 in 21	9 =	2 in 21	9 =	9	9
Medulla	16	60	12	40	2	6	18 in 90	20	13 in 90	14 = 31 in 90	34	34
Cerebellum	150	83	75	45	18	12	5 in 11	45	1 in 11	10 = 6 in 11	54	54
Corpora quadrigemina	9	69	8	61	1	..						
Total	401 in 568 cases = 70 per cent.		172 in 568 cases = 30 per cent.		101 in 568 cases = 17 per cent.		82 in 302 cases = 22 per cent.					

brain substance and displacement of its fluids. On the other hand, the pain is most certain to occur, and also to be most violent, when the tumor grows in the cerebellum under the tense fold of the tentorium; it is least likely to occur when room is left for the expansion of the growth at the interpeduncular space. In the pons and medulla, direct irritation of the trigeminus may add a special liability to pain. The great liability to head-

Case, by King (*Brain*, October, 1882): Two tumors, one on right side of pons extending to left middle peduncle of the cerebellum, the second embedded in the left side of the floor of the fourth ventricle; convulsions flattened, much serum in ventricles, showing extreme intracranial pressure; but optic neuritis developed only after attacks of coma. Headache, but no vomiting.

The immediate cause of vomiting is supposed to be al-

TABLE III.

Seat of tumor.	INTELLIGENCE DISTURBED.										INTELLIGENCE NORMAL.	
	Mental depression, apathy, loss of memory, imbecility.		Hallucination.		Delirium or mania.		Drowsiness or stupor.		Total.		Cases.	Per cent.
	Cases.	Per cent.	Cases.	Per cent.	Cases.	Per cent.	Cases.	Per cent.	Cases.	Per cent.	Cases.	Per cent.
Medulla, 29 cases	6	20	2	7	2	7	1	3.5	11	38	18	62
Cerebellum, 162 cases	48	29	1	..	6	3	9	5	64	39	98	60
Cortex, 57 cases	..	..	..	..	..	..	..	..	28	49	..	..
Pons, 56 cases	27	48	1	..	..	..	1	..	29	51.5	27	48.5
Basal ganglia, 40 cases	18	45	1	..	2	..	..	..	21	52	19	47
Lobes, 192 cases	90	46.5	9	4	11	5.5	5	2.5	115	60	77	40
Occipital	1	..	..	..	..	..	..	..	..	..	1	..
Frontal	6	10	..	..	..	..	..	..	6	10	11	19
Parietal	9	15.5	1	..	2	..	..	..	7	12	19	29.5
Temporal	2	3	..	..	..	..	..	..	..	..	..	..
Corpora quadrigemina, 13 cases	4	30	..	..	2	15	4	30	10	77	3	23

ways the excitation of a vomiting centre in the medulla; and this can be brought about by pressure transmitted from any part of the brain. This pressure is, however, more direct when exercised from some point in the posterior cranial fossa; hence a second reason for the intensity of the symptom in cases of tumor of this locality.

The vomiting is unattended by nausea and occurs on an empty stomach and with a clean tongue, and in these respects contrasts markedly with the vomiting of uræmia. It is apt to follow the headache closely, and, as in migraine, to occur at the height of the paroxysm of pain, and also in the early morning.

Epileptiform Convulsions constitute a fourth diffused symptom, which is very characteristic of tumors of the brain. Their causal relations to increased intracranial pressure have been strikingly shown by Leyden's experiments. In these, pressure was directly applied to the brain of animals previously trepanned for the purpose. Convulsions occurred as soon as the pressure had risen to 130 mm. of mercury. Pressure, however, is only one of the mechanisms by which convulsions may be excited. Kussmaul's experiments, made many years ago, showed that sudden anæmia of the brain, such as might be induced by copious hemorrhage, was invariably followed by convulsions. The predominance of convulsions in cases of brain tumor, according to the locality occupied by the latter, does not follow the law which is applicable to symptoms traceable to increased pressure, for convulsions occur oftenest in cases of tumor of the cortex and cerebral lobes, presumably of the portions of the centrum ovale which lie immediately beneath the cortex. General convulsions, therefore, like local spasms, are rendered imminent by direct excitation of the motor tracts. Curiously enough, convulsions are almost excluded from the symptomatology of the pons, though this region, which is traversed in every direction by motor tracts, probably contains the convulsing centre. But apparently the properties of the centre become abolished before they can be effectually irritated. This absence of convulsions, when certain positive signs are present at the same time, is of real value in localizing a tumor in the pons.

As the convulsion is not proportioned to the locality of greatest tension, so it stands in no relation to the time at which tension is greatest. It occurs as an initial symptom, or during the active period of the disease; but it usually disappears, with other irritative symptoms, in some other manner toward the close, when intracranial pressure is at its maximum. Sudden variations in such pressure, caused by fluctuations of the circulation, seem to be the essential proximate cause of the convulsions of brain tumors. The form of the convulsion does not differ from that observed in idiopathic epilepsy, and the diagnosis between tumor and epilepsy is often difficult.

It can be made only by means of the concomitant symptoms. Convulsions occurring in adult life for the first time should at once excite suspicion of brain tumor and lead to an ophthalmoscopic examination for choked disc. According to Bruns, convulsions may occasionally precede for years, and with intermittences of years, all other symptoms of an intracranial growth.

Apoptiform Attacks occur with brain tumors, and may, though rarely, be the first symptom, and followed by paralysis or paresis. It is extremely difficult, then, to distinguish the case from one of ordinary cerebral hemorrhage. Hemorrhage into or around the tumor is a frequent cause of apoplexy, and thus may first reveal the existence of a tumor hitherto latent; or it may occur incidentally among phenomena already well defined and recognized. Finally, the apoplectic attack may usher in the terminal period; the patient never completely recovering, but passing into a soporose condition and finally into coma. The apoplectic ictus is not invariably associated with hemorrhage; it may be due to sudden alterations of intracranial pressure, by which the functions of brain tissue are temporarily suspended, as after concussion.

Psychic Changes.—The earliest is usually an extreme irritability, which contrasts with the lachrymose emotionality characteristic of softening of the brain. Occasionally this culminates in attacks of maniacal excitement; oftener, however, the patient suffers from melancholic depression, and gradually becomes more and more apathetic and taciturn. This taciturnity, which is a diffused symptom, must be distinguished from true aphasia. As in all mental disturbances, the memory fails. Dementia may precede death for some time, especially if epileptic convulsions have been severe. The specific psychic symptom of brain tumor is drowsiness, from which it is often difficult to rouse the patient. When roused, however, his mind may seem unexpectedly clear. The drowsiness is proportioned to the degree of general intracranial pressure. It is particularly marked in tumors of the frontal lobes, which may reach a considerable size without occasioning other symptoms.

Table III. shows that the liability to psychic symptoms other than drowsiness is not at its maximum when the tumor is seated at the cortex, nor when a cortical tumor is in the frontal lobes. Cortical tumors stand third from the bottom of the scale in this respect; the highest place is occupied by tumors of the corpora quadrigemina, seventy-seven per cent. A relative infrequency of mental disturbances is observed in tumors of the medulla and pons. On the other hand, the high percentage of such disturbances in tumors of the centrum ovale may probably be, at least in part, attributed to their influence upon the cortex. To such influence must, in last analysis, all psychic perversions be ascribed; and the high proportion of cases in which these are present with tumor in any locality of the brain is explained by the extreme sensitiveness of the cortical substance to disturbance of the intracranial pressure from whatever point diffused. Psychic symptoms, of one kind or another, are seen to be extremely frequent in tumors of the brain, being present in about half the cases. Their presence, therefore, materially aids in establishing the diagnosis. Certain specific psychoses, as paranoia and hysteria, are occasionally excited by the presence of a brain tumor.

Choked Disc.—This symptom, when present, is more nearly pathognomonic than any other of brain tumor. According to Oppenheim, ninety per cent. of all cases of

choked disc are due to intracranial growths. The choked disc has been differently regarded as the expression of two different morbid processes: an inflammation of the optic nerve, "neuritis optica," or a mechanical obstruction to its circulation, which should be the choked disc proper. Oppenheim notes that in tumors of the base of the cranium, which are liable to obstruct the flow of lymph into the sheath of the optic nerve, the choked disc is usually lacking, and tumors of the optic nerve itself are apt to lead to direct atrophy of the nerve without any preliminary stage of choked disc. These facts are counted as an argument in support of the celebrated doctrine of von Graefe, who attributed the choked disc in all cases to an obstruction offered to the venous circulation of the optic nerve, from immediate or mediate pressure exercised upon the sinus cavernosus; hence a serous transudation from the veins, rendering the papilla swollen and oedematous. As seen with the ophthalmoscope the papilla appears engorged, tumefied, nebulous, irregular, and with ill-defined edges; a spirus of cloud covers both the centre and the circumference, rendering the whole surface opaque. The arteries are diminished in calibre, the veins appear interrupted at various points.

TABLE IV.—CASES OF DIFFUSED SYMPTOMS ALONE.

Seat.	Headache.	Headache and vomiting.	Headache and convulsions.	Headache and choked disc.	Headache, convulsions, and vomiting.	Headache, convulsions, and choked disc.	Headache, convulsions, vomiting, and choked disc.	Headache, vomiting, and choked disc.	Vomiting.	Convulsions.	Convulsion and choked disc.	Psychic alteration.	Total.
Cortex, 57 cases	4	3	1	2	4	1	..	3	2	1	1	In 7 of these.....	11 = 19 per cent.
Lobes, 124 cases	3	3	8	..	..	..	..	..	..	..	..	In 22 of these.....	37 = 29 per cent.
Basal ganglia, 26 cases	1	..	..	..	3	..	..	..	..	..	..	1 alone, 1 besides..	6 = 23 per cent.
Cerebellum, 90 cases	6	1	..	..	..	..	..	..	..	..	..	In 4 of these.....	17 = 18.5 per cent.
Total.....	13	13	10	2	7	6	..	7	2	8	2	35	71 = 23.8 per cent.

In one form the capillaries are increased in size, in the other they are effaced.

Bruns considers these two forms simply gradations of each other, the neuritis optica being the incipient stage, the choked disc proper the advanced stage of the same process. When the arteries have almost ceased to be distinguishable, except at the periphery of the retina, small hemorrhages usually form in the retina, and spots of fatty degeneration are seen, the latter being a serious threat of speedy blindness.

Against the doctrine of venous obstruction as a cause of choked disc, it has been urged that the free inoculation of the ophthalmic vein with the angular branch of the facial suffices to avert complete venous obstruction, even when the circulation in the cavernous sinus has been retarded. Further, a free communication has been demonstrated between the intervaginal lymphatic space of the optic nerve and the subarachnoid space of the brain. It has been shown that a rise of intracranial pressure suffices to force cerebro-spinal fluid into the intervaginal space of the nerve, thus causing compression of its central vessels, local obstruction, and swelling from transudation, apart from venous obstructions.

Choked disc sometimes appears in cases in which the tumor is so small that much increase of intracranial pressure seems doubtful. It is then more probably due to inflammation of the optic nerve, first propagated from irritated brain tissue to the central terminations of the nerve, neuritis from diffused cerebritis (Mackenzie), or excited by direct pressure upon the optic tract. Such direct pressure is exercised by tumors of the corpora quadrigemina, the chiasma, the cerebral peduncles, or the interpeduncular space.

Choked disc is found far more frequently (54 per cent.) in cases in which the tumor involves the corpora quadrigemina, than in those in which it involves any other part of the brain. The smallest percentage is in the class of cases in which the basal ganglia are the seat of the tumor. When there is direct pressure on the optic tract, the

papilla sometimes atrophies without passing through any stage of choked disc. Until atrophy sets in, vision is not necessarily impaired. Thus, out of a total of 82 cases of choked disc, vision remained intact in 37, or 45 per cent. In a great many cases no ophthalmoscopic examination is made, unless vision is impaired, and this explains why such examination is lacking to the history in 232 out of 485 observations analyzed by Bernhardt (47.8 per cent.). In many of these negative cases it is very possible that choked disc really existed, so that the real proportion of this lesion in brain tumor cannot be considered as known.

The ten per cent. of cases of choked disc which are not caused by intracranial growths have a very diverse etiology. The condition has been seen in pernicious anemia; in a few cases of arteriosclerosis, when the arteries of the optic nerve are involved; in abscess; in multiple sclerosis.

In a certain number of cases cerebral tumor manifests itself exclusively by one or more of the foregoing "diffuse" symptoms. Among Bernhardt's cases of tumors of the cortex, centrum ovale, cerebellum, and basal ganglia, this limitation may be found 71 times out of a total of 297 cases, or 23.8 per cent.

The existence of mental symptoms in a large proportion of these cases (49 per cent. of them) is the circumstance that might, perhaps, most surely guide in the diagnosis, otherwise so difficult.

The proximate consequences of increased intracranial pressure, which are the immediate cause of the diffused symptoms, have been differently interpreted. It was long maintained that the brain substance was nearly as incompressible as water. Room, therefore, could be made within the cranium for a neoplasm only by proportionate expulsion of blood and lymph, and by atrophy of the brain tissues in the immediate vicinity of the tumor. Adamkiewicz's experiments have shown, however, that the nerve tissue surrounding the tumor is compressed, *i.e.*, its solid molecules are approximated, and the fluid normally interposed between them is, to a greater or less extent, expelled. For, when a piece of laminaria was inserted under the skull of an animal previously trepanned for the purpose, and was allowed to swell, thus rapidly encroaching upon the intracranial space, microscopic examination of the tissue in which the foreign body was embedded revealed the fact that all the nerve elements of this tissue were closely crowded together, thus apparently multiplied in a given space. The zone adjacent to this was intensely vascularized from dilatation and new development of capillaries, and, in addition, it was hypertrophied from proliferation of connective tissue.

In the experiment, the swelling of the laminaria was much more rapid than is the growth of any tumor, and the condensation and nutritive irritation of tissue were therefore exaggerated. To a greater or less extent, however, both these lesions must always be produced by the presence of a foreign body within the cavity of the cranium. Only when the tumor grows very slowly are they absent, or reduced to such a minimum as to occasion no symptoms, either diffused or focal.

The elements of gliomatous tumors are the most liable to so insinuate themselves between the elements of the

brain tissue as to avoid compression, and no well-defined line of demarcation separates the tumor from the brain mass. In this respect the sarcomata contrast markedly, and may be distinguished by the naked eye by the zone of softening which circumscribes them. Carcinomata and tubercle directly destroy brain tissue and take its place.

The occurrence, in twenty-three per cent. of the cases, of diffused without focal symptoms indicates that the centres of origin of nerve tracts have remained unaffected, though the vomiting and convulsive centres and the nervous filaments of the dura mater have been irritated; that lymph has been forced into the sheath of the optic nerve, or that a descending neuritis has been excited by propagation from the zone of cerebritis surrounding the tumor; and that the delicate psychic mechanisms of the cerebral cortex have been irreparably jarred and are out of working order.

This immunity of motor, sensory, or special-sense nerve functions is usually due to the localization of the tumor in a "latent" portion of the brain; but it is also sometimes observed in cases in which the tumor occupies a (presumable) focus of nerve origin. Thus, although there can be no doubt that the ultimate origin of the motor nerves contained in the pyramidal tracts is in the central gyri and paracentral lobule, tumors seated in these localities have sometimes been observed entirely unaccompanied by motor symptoms, either irritative or paralytic. Two such cases are contained among the eleven of the table. In one of these there were forty hydatid cysts in the brain, a form of neoplasm very frequently latent. In the second case, however, there was a most extensive sarcoma occupying the lower half of the anterior central gyrus, posterior half of third frontal gyrus, and under half of insula.

Two explanations are offered for these cases. First, that the elements of the neoplasm have insinuated themselves so gradually between those of the nerve tissue, or have displaced them with so little injury, that the functions of this tissue have not suffered. This explanation applies to cases in which, instead of the cells of a nucleus of origin, the fibres of a nerve tract have been displaced, as in some extraordinary cases on record in which a tumor has occupied nearly the entire pons, yet has occasioned no motor symptoms. The second explanation applies only to cortical centres. According to Exner, the different mechanisms of the cortex, though specially concentrated at certain localities, exert their influence somewhat beyond these limits, though with constantly diminishing intensity and effectiveness. Hence it is occasionally possible, though the main centre be destroyed, that its action may be supplemented by that of others habitually subordinate.

In more than three-fourths of the cases of brain tumor, in addition to the diffused symptoms hitherto described, the patient suffers from perversions or abolition of one or more cerebral functions other than psychic ones. These are more known as the focal symptoms.

The simplest focal symptoms are those elicitable by percussion and auscultation of the cranium. In a certain number of cases, careful percussion awakens pain over a definitely limited area; and elicits also a peculiar tympanitic sound (Macewen), indicative of a marked thinning of the cranial bone, and due to the more extensive vibrations of air in the nose and mouth which occur when the skull is thinner than normal. In a few rare cases auscultation discovers another sound, an arterial murmur synchronous with the arterial pulse. This is conspicuously heard with aneurisms, but is by no means confined to them. It is analogous to the murmur which may be heard in rachitic children or in those with open fontanels, or even in certain cases of intense anemia. Other focal symptoms, and far more frequently encountered than the foregoing, depend on the perversion or abolition of mobility or sensibility in one or more cranial nerves or spinal nerve tracts; or on similar alterations of one or more of the special senses. Among the latter, however, is to be expected the impairment of vision directly traceable to choked disc or optic neuritis. An intense interest has

recently attached to these symptoms as a means of unravelling the physiological problems of the localization of brain functions. For this purpose, however, the study of tumors is much less valuable than that of other brain lesions, such as, for example, localized softening; for their limits are irregular, and their effects, through transmission of pressure, often diffuse themselves in structural or functional changes far beyond these visible limits. For clinical purposes, therefore, it is necessary to ascertain first what symptoms are generated by lesions really limited to certain localities; second, to what extent the complication of these by others, diffused or symptomatic of different localities, may aid us in diagnosing a tumor instead of any other focal disease.

Focal symptoms are always unilateral at the beginning—a most useful criterion in distinguishing tumor from diffused disease of the brain. The appearance of symptoms on the side of the body opposite to that where they first began indicates an extension of the tumor across the median line, except when parts are affected which are endowed with bilateral cortical innervation. Extension of the growth across the median line, for obvious reasons, most frequently occurs at the narrowest regions of the encephalon, the pons and (though less frequently) the medulla. It is, however, also seen in tumors of the corpus callosum, but the second hemiparalysis is much slighter than the first.

Case (Bristowe, *Brain*, October, 1884): Illness twelve weeks. Left hemiplegia, gradually extending to right side; then general paralysis, principally on the left side, ten days before death. Progressive drowsiness or stupidity, aphasia. Sarcoma occupied anterior two-thirds of fornix and corpus callosum, extending into the centrum ovale in both hemispheres, but principally in the right.

In addition to these symptoms involving purely cerebral functions, the functions of respiration and circulation are sometimes modified from the direct or indirect morbid influence exercised upon the medullary centres.

Lesions of Motility.—These are by far the most numerous, the most varied in character and in combination of all the focal symptoms of brain tumor. They belong to three different classes: First, irritative, including tremors, choreiform movements, local spasms,* and Jacksonian epilepsy; second, paralytic, consisting in the partial or complete abolition of motive power; third, ataxic, implying inco-ordination among functionally combined movements.

Irritative Lesions of Motility.—A fine tremor or a clonic spasm, incessant or periodically repeated, is often seen, either in muscles which have already become paralyzed, or in those which become paralyzed at a later date.

Case (Berger, *Arch. der Heilkunde*, XIX. Jahr.): Woman, aged forty-eight. During a year, about every eight days, an attack of clonic spasms in the right arm, then paralysis of the same arm, followed by paresis of the buccal branches of the right facial; clonic spasms persist after paralysis sets in; death a week later. Tumor in left anterior central gyrus, compressing the posterior and second frontal gyri.

Case (Berkley, *Med. News*, 1882): Patient with spasm of the left angle of the mouth for two and a half years. Sudden death from cardiac disease. Calcareous nodule three-sixteenths of an inch in diameter on the right ascending frontal convolution, an inch and a half above the fissure of Sylvius; the locality corresponds to Ferrier's centre for the zygomatic muscles.

Tremors and localized spasms are valuable diagnostic symptoms; for, first, they are more frequent with tumors than with other localized brain lesions; second, they are more frequent in the cortex; and, third, they are especially frequent in the motor zones. All these circumstances are demonstrated by the following tables. The first is compiled from Exner's collection of one hundred and sixty-four cases, exclusively of cortical lesions.

Tumors of cortex (44 cases): Spasm, 3 = 6.5 per cent.; spasm and paralysis, 14 = 31 per cent.; paralysis, 14 = 31

* The general epileptiform convulsions being a diffuse symptom.